# Miocene Floras of the Columbia Plateau

## Part I. COMPOSITION AND INTERPRETATION

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## Part II. SYSTEMATIC CONSIDERATIONS

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# PART II. SYSTEMATIC CONSIDERATIONS

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## SYSTEMATIC DESCRIPTIONS

Identification of the Miocene plants here described, begun by the senior author in 1920 and continued by several students and associates in later years, was brought nearly to completion by the junior author in 1946. Since then several changes have been made, following the discovery of Metasequoia by Miki, which express our more complete understanding of several other species whose modern relationships had been inadequately known. We are confident that the floral lists as now constituted give a much more reliable basis for interpretation of Miocene vegetation in western North America than has previously been possible.

Most of the material available for study represents foliage, but fruits and seeds have also been a basis for our generic determinations in the case of twenty-nine species. Additional confirmation comes with Gray's pollen studies, which show a close correspondence between the lists of megafossils and microfossils; she has recognized pollen of twenty-four of our genera, and has made several determinations at family level which are consistent with the floras as now known. Our understanding of Tertiary vegetation will be further increased when specimens of wood associated with the leaves have been more fully studied, for the unpublished results of Beck's work to date show a marked correspondence with the leaves recognized in the Stinking Water flora.

We take pleasure in acknowledging the services of Victor G. Duran, Biological Photographer at the University of California, and of Walter B. Schwarz, Scientific Illustrator, in the preparation of our plates for publication.

In addition to the descriptions of species recognized from the Mascall, Blue Mountains, and Stinking Water floras, we have included discussion or descriptions of material related to the present study from floras of about the same age collected in adjacent areas. Following the descriptions, we have listed material of uncertain systematic status, and have given a complete list of revisions.

The following abbreviations are used to denote the institutions in which cited specimens are deposited:

U. C. M. P., University of California, Museum of Paleontology. Paleobot. coll. refers to paleobotanical collections, for which serial numbers are given to type specimens.
U. S. N. M., United States National Museum.
U. M. M. P., University of Michigan, Museum of Paleontology.
U. C. W. M., University of Chicago, Walker Museum.

An error of many years' standing is here corrected, involving the assignment of type numbers already in use. When Knowlton studied the University of California collections in 1901, after a field season with Merriam in the John Day Basin, he numbered many specimens and cited them in his Fossil Flora of the John Day Basin (1902). Forty-one of these numbers involved material in the Mascall flora. Chaney and his students later used these numbers for type specimens in several Tertiary floras, without noting that they had been previously assigned. The only feasible way of resolving this difficulty is to consider Knowlton's specimens as belonging to an earlier series of numbers. To indicate their distinct status, the older specimens involved in this duplication now have the letters "O.S." preceding their numbers, an abbreviation for "Old Series." The specimens incorrectly numbered by Chaney retain the numbers he assigned, since all of them have been so cited in print.

### Family GINKGOACEAE

#### *Ginkgo adiantoides* (Unger) Heer

(Plate 11, figure 5)

*Ginkgo adiantoides* (Unger) Heer, Flora Foss. Arct., vol. 5, pt. 3, p. 21, pl. 2, figs. 7-10, 1878.
Mason, Carnegie Inst. Wash. Pub. 346, p. 145, pl. 1, fig. 1, 1927.
Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, p. 83, pl. 2, fig. 4, 1937.
*Ginkgo* sp. Knowlton, U. S. Geol. Surv. Bull. 204, p. 23, pl. 1, fig. 5, 1902.

Ginkgo is represented at four of the six localities in the Mascall formation, but has not been found in the Blue Mountains or the Stinking Water flora. Impressions of its leaves are uncommon except at the Roadcut locality (loc. P4129), where it is the most abundant species. Here its leaves are preserved in brown ashy clay of fluviatile origin. In view of the great numbers of fallen leaves under a living maidenhair tree at the period of shedding, it seems possible to account for this local abundance of *Ginkgo adiantoides* in the record as resulting from a single tree, or group of trees, whose branches extended over the stream. Its sparse representation elsewhere in the Mascall forest, and at other Miocene localities on the Columbia Plateau, suggests that it was nowhere an abundant tree, though it may have been more common on slopes so far removed from lakes and flood plains that its leaves were seldom blown or washed into the basins of deposition.

In the somewhat older Eagle Creek flora of the Columbia Gorge (Chaney, 1920) and Molalla flora to the west of the Cascades, Ginkgo leaves are much more numerous. This may be a reflection of a different habitat. It is also reasonable to suppose that trees of G. adiantoides may have been more numerous in the mixed deciduous forest at this earlier time, whereas the Mascall record shows it approaching its time of extinction in North America. In any event, this is the latest known occurrence of Ginkgo in the Western Hemisphere.

None of the leaves of G. adiantoides from the Tertiary of the Northern Hemisphere are known to have the bilobate form which gives the living species its name.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P28, P4129), hypotype no. 123, homeotypes nos. 2820-2823 incl. Succor Creek, Ore.: U. M. M. P. Upper Cedarville, Nev.-Cal.: U. C. M. P. (locs. P97, P115), hypotype no. 829. Latah, Wash.: U. S. N. M. (Spokane, Grand Coulee locs.).

## Family TAXACEAE

### Cephalotaxus bonseri (Knowlton) new combination

(Plate 11, figure 13)

Tumion bonseri Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 25, pl. 10, fig. 3, 1926.
Taxites olriki ? Heer. Lesquereux, Rept. U. S. Geol. Surv. Terr., vol. 8, p. 240, pl. 50, figs. 6, 6a, 1883.
Condit, Carnegie Inst. Wash. Pub. 476, p. 252, 1938.
Sequoia angustifolia Lesquereux, Rept. U. S. Geol. Surv. Terr., vol. 8, p. 240, pl. 50, figs. 5, 5a, 1883.

Microscopic examination of the type specimen of Tumion bonseri Knowlton from the Latah flora shows two important features not previously reported. In the first place, the specimen has now been fully cleaned and it is apparent that the needles are not blunt, as the illustration leads one to believe, but are long and tapering. Secondly, the stomatal bands are not in grooves, as is characteristic of Torreya, but are on the surface of the needle; Knowlton was originally noncommittal on this point.

Comparison of this material with several modern genera of conifers shows that it cannot be separated from needles of Cephalotaxus. Similar material has been identified previously in the Neroly flora at Corral Hollow as Sequoia angustifolia Lesquereux and Taxites olriki ? Heer by Lesquereux and Condit. From the Eocene of Alaska Hollick (1936, pl. 16, figs. 6-8) has figured as Taxites olriki Heer specimens that appear to be closely related to our Miocene species, and further study may show that they are inseparable. In recent years Wilder has collected a large number of fine specimens of Cephalotaxus from the Lower Miocene Molalla flora of north-central Oregon, and these seem indistinguishable from the Latah and Neroly material; we are figuring one of these Molalla specimens on plate 11, and identify it as Cephalotaxus bonseri.

The material identified by LaMotte as Torreya bonseri (Knowlton) LaMotte (1936, pl. 3, fig. 9) is now considered to represent Abies chaneyi Mason, as discussed below. In his synonymy for T. bonseri, Brown (1937a, p. 167) has also included Torreya sp. Mason from the Lower John Day flora at Cant's Ranch. Inspection of the specimens shows that they are Torreya, and in our opinion they represent the only undoubted material of that genus in the Pacific region. This species was recently named Torreya geometrorum (Cockerell) MacGinitie (MacGinitie, 1953). Both the Cant's Ranch and the Florissant specimens resemble needles of the modern T. grandis Fortune (T. fargesii Franchet) of China, differing from the American T. californica Torrey and T. taxifolia Nuttall in having a greater width in proportion to length. These specimens are similar also to T. borealis Heer (Heer, 1883, vol. 7, pl. 70, fig. 7a) from west Greenland, and future studies may show that they are indistinguishable.

Occurrence. Latah, Wash.: U. S. N. M. (Spokane loc.). Molalla, Ore.: U. C. M. P. (loc. P3919), hypotype no. 3247. Neroly, Cal.: U. C. M. P. (Corral Hollow loc.), hypotype no. 1938.

### Cephalotaxus californica Potbury

(Plate 11, figure 12)

Cephalotaxus californica Potbury, Carnegie Inst. Wash. Pub. 465, p. 61, pl. 2, fig. 2, 1935.

Two needles in the Mascall flora, characterized by very wide stomatal bands on each side of the midrib, are easily duplicated in the fine suite of Cephalotaxus californica specimens from the LaPorte flora. All this material shows relationship to needles of the modern Cephalotaxus (Amentotaxus) argotaenia Pilger, a little-known tree found in moist ravines in the Hupeh and Szechuan provinces of central China.

The only other fossils in the Tertiary of western North America that resemble this species are needles recorded by Hollick from the early Tertiary of Alaska as Taxites olriki Heer (1936, pl. 16, figs. 6-8). They may represent Cephalotaxus, but these specimens seem closer to the modern C. fortunei Hooker and to the Miocene C. bonseri (Knowlton) Chaney and Axelrod than to C. californica Potbury, which has needles fully twice as broad. Needles of the form genus Cephalotaxopsis have been recorded from a number of Upper Cretaceous localities in North America. A general resemblance to

*Cephalotaxus californica* is shown by *C. magnifolia* Fontaine from Virginia (Fontaine, 1889, pl. 105) and by certain specimens of *C. magnifolia successiva* Hollick from Alaska (Hollick, 1930, pl. 16, figs. 1a, 2, 3a, 4-7a). These fossils also have more slender needles than the Mascall species, and the stomatal bands do not appear as wide.

*Occurrence*. Mascall, Ore.: U. C. M. P. (locs. P3735, P28), hypotype no. 2824, homeotype no. 2825.

### Family PINACEAE

### *Abies chaneyi* Mason

(Plate 11, figures 1-3)

*Abies chaneyi* Mason, Carnegie Inst. Wash. Pub. 346, p. 149, pl. 4, figs. 1, 2, 7, 1927.
*Abies* sp. 1 Mason, ibid., p. 151, pl. 4, fig. 4, 1927.
*Torreya bonseri* (Knowlton) LaMotte, Carnegie Inst. Wash. Pub. 455, p. 108, pl. 3, fig. 9, 1936.

Brown (1940, p. 347) has expressed the opinion that the branchlets of *Abies chaneyi* are more nearly like those of the living *A. concolor* Lindley and Gordon than those of *A. venusta* (Douglas) Koch, and has placed this material in synonymy under *A. concoloroides* Brown. This suggestion was based on his belief that the strong curvature displayed by the fossil needles is not present in the living Santa Lucia fir. We note, however, that *A. venusta* commonly has its needles curved, both in herbarium material and on the living tree. An even more important reason for comparing these fossil needles with a *venusta* type of fir is that they are gradually attenuated and taper to a sharp prickle; *A. concolor*, on the other hand, has blunt needles.

Mason originally pointed out that the leaves of *A. chaneyi* differ from those of the typical *A. venusta* in being somewhat more slender and in having a more attenuated tip. Shade forms of the living *A. venusta* (U.C. Herbarium sheet 186117) may closely resemble the fossil *A. chaneyi* in both shape and tip. Since the Miocene *A. chaneyi* is presumed to have lived in a much more humid environment than the modern *A. venusta*, it is to be expected that its leaves would be more slender and show less of the xeric characters displayed by the modern Santa Lucia fir, which lives today mostly on exposed slopes in the oak-madrone and chaparral country of the central Santa Lucia Mountains. This tendency of plants to develop smaller and thicker-textured foliar organs in response to increased aridity in later Cenozoic time is commonly displayed in such angiosperm genera as Acer, Amelanchier, Populus, Quercus, Rosa, and Ulmus (Chaney, 1938b; Axelrod, 1944f).

Another important character shown by foliage shoots of the type material of *A. chaneyi* in the Mascall flora, and also by individual needles from the Stinking Water flora, is that the bases are strongly truncated so that the needles do not taper to a petiole. This feature is not commonly seen in needles of the living *A. venusta*, but may occasionally be present (U. C. Herbarium sheets 632489, 139982, 186117). *Cephalotaxus fortunei* Hooker, of central China, has needles strikingly like those of *A. chaneyi*, especially in the long tapering tip, but in Cephalotaxus the base of the needle tapers to the petiole and is not sharply truncated as in *A. chaneyi*. In addition, the texture of Cephalotaxus needles is not so heavy as that of the fossil and of the living *A. venusta*.

Brown (1940, p. 354) is of the opinion that the seeds assigned to *A. chaneyi* by Mason are properly referable to Cedrela.[1] Examination of these seeds and of supplementary material in our new collections, and comparison with other seeds which have been assigned to Cedrela, brings out two differences: (a) the wing does not flank the seed as in Cedrela, but is completely terminal in its expanded portion; (b) some of the seeds show a prominent groove just off the mid-line of the long axis which is interpreted as representing the gap where the wing did not completely clasp the seed. Whereas these specimens are considered to represent Abies rather than Cedrela, they differ from seeds of *A. venusta* in that the fossil seed and attached wing are somewhat larger than the average for *A. venusta*, and the seed is more slender in proportion to its length.

Besides those mentioned by Mason and those noted above, the following characters distinguish *A. chaneyi* from the modern species: In the fossils, the bract is not so attenuated as that of the modern *A. venusta*, but is widest at the level of the distal part of the scale, whereas that of *A. venusta* is essentially needle-like for its entire length; there is no evidence of the two lateral appendages near the base of the bract; the scale in *A. chaneyi* is somewhat wider than that of the modern *A. venusta*. Such minor differences are to be expected in a Miocene species of Abies, but the general appearance of our specimens fully confirms their assignment to the *venusta* section of the genus.

Examination of the twig identified as *Torreya bonseri* (Knowlton) LaMotte demonstrates that it is not Torreya, but falls readily within the range of variation of *Abies chaneyi*. It cannot be Torreya because the needles of that genus regularly have tapering mucronate tips; the needles on the twig from Forty-nine Camp have acute as well as mucronate tips, a feature duplicated in *A. venusta*, as shown on sheets 197272 and 66531 in the University of California Herbarium. The stout twig also is typical of *A. venusta*, whereas the twigs of Torreya regularly are much more slender. As for the other specimens cited by LaMotte in synonymy under *T. bonseri*, the type material of *T. (Tumion) bonseri* Knowlton from the Latah flora represents *Cephalotaxus bonseri*

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[1] The specimens figured by Mason are counterparts. Figure 1 is somewhat misleading; the seed is not falcate, for its edge lies along the axis of the needle beside it.

(Knowlton) Chaney and Axelrod, as shown on an earlier page, and the specimens of Torreya sp. Mason from Bridge Creek are now regarded as T. geometrorum (Cockerell) MacGinitie (MacGinitie, 1953, p. 81).

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P28, P4129), syntypes nos. 134, 135, 136, hypotype no. 2826, homeotypes nos. 2827, 2828, 2829. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 2830, 2831, homeotypes nos. 2832, 2833. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotype no. 777.

### Abies concoloroides Brown

(Plate 11, figure 4)

Abies concoloroides Brown, Jour. Wash. Acad. Sci., vol. 30, p. 347, 1940.
Abies chaneyi Mason. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 167, pl. 45, figs. 23, 24, 1937.

The cone scale and branchlet from the Blue Mountains flora figured originally by Brown as Abies chaneyi Mason, and subsequently renamed by him A. concoloroides, form the types of the species (Brown, 1940, p. 347). We have in our Blue Mountains collection 3 fir seeds, but only one of them seems properly assignable to this species; the others we identify as A. laticarpus MacGinitie. The specimen of A. concoloroides is a small seed, probably produced near the end of the cone, with a wing that is not broadly asymmetrical distally as in A. laticarpus. The cone scale figured by Brown closely resembles those produced by the living A. concolor Lindley and Gordon. It differs from A. laticarpus in that the proximal part is wider and the distal part is broadly curving. These features give it an over-all rectangular outline, rather than the rough wedge shape which is typical of cone scales of A. laticarpus and of the modern A. magnifica Murray, with which it has been compared. The branchlet and attached needles figured by Brown also seem more representative of a concolor than a magnifica type of fir.

The fir seed from the Mascall flora figured by Mason as A. magnifica var. shastensis has been considered by Brown to represent A. concoloroides (Brown, 1940, p. 347). As is pointed out below, it differs from normal concolor seeds in that the attached wing is considerably widened and asymmetrical distally, whereas in A. concolor the wing is only slightly wider distally and has an over-all symmetrical and roughly rectangular outline.

Penhallow has figured fir scales from the Quilchena flora of British Columbia which show a general resemblance to A. concoloroides (1908, p. 68, figs. 20, 21). These specimens, figured as Pinus steenstrupiana Heer, differ from A. concoloroides in that the scale has a somewhat longer stalk and the distal edge is less rounded; the fossils do not appear to be greatly different from cone scales produced by the modern A. amabilis (Douglas) Forbes.

Occurrence. Blue Mountains, Ore.: U.S.N.M. (Tipton loc.); U. C. M. P. (loc. P3936), hypotype no. 2834.

### Abies klamathensis Axelrod

Abies klamathensis Axelrod, Carnegie Inst. Wash. Pub. 553, p. 250, pl. 42, figs. 6, 7, 9, 12, 13, 1944.
Abies magnifica var. shastensis Lemmon. Mason, Carnegie Inst. Wash. Pub. 346, p. 150, pl. 4, figs. 5, 6, 1927.

Brown (1940), p. 347) has questioned the reference of the scale and bract described by Mason (his fig. 6) to Abies magnifica var. shastensis Lemmon, and has suggested that the bract differs from that of A. chaneyi only because its tip has been broken off. Axelrod has subsequently studied this specimen (1944f, p. 250), and has concluded that Mason was correct in believing that it was distinct from A. chaneyi, and in comparing it with A. magnifica var. shastensis. To this fossil and two others like it from the Alvord Creek flora of southeastern Oregon he applied the name Abies klamathensis. Three seeds with asymmetrical wings were also assigned to A. klamathensis.

The interpretation of Mason's material has been complicated by Brown's opinion (1940, p. 347) that the foliage of A. chaneyi is referable to A. concoloroides Brown, and in assigning the seed (Mason's fig. 5) also to that species. We have expressed the opinion in the discussion of A. chaneyi above that Mason was correct in indicating the resemblance of his foliage specimens (pl. 4, figs. 1, 7) to the living A. venusta (Douglas) Koch, and that these and others recently collected are properly referable to A. chaneyi. We further agree with Mason that this seed specimen is of the modern shastensis rather than of the concolor type, since the wing is asymmetrical rather than broadly rectangular.

We conclude that Mason's specimens, and others subsequently collected in the Mascall formation, are assignable to A. klamathensis, whose general resemblance is to the living A. magnifica var. shastensis. This modern endemic is found in the Klamath Mountains of northern California and in the southern Sierra Nevada. A number of its modern associates, such as Abies concolor, Acer glabrum, A. macrophyllum, Alnus tenuifolia, Amelanchier alnifolia, Betula fontinalis, Cornus californica, C. nuttallii, Lithocarpus densiflora, Mahonia repens, Populus tremuloides, P. trichocarpa, Pseudotsuga taxifolia, and Rosa californica, have close equivalents in the Miocene floras of the Columbia Plateau.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P4129), syntypes nos. 137, 139, 151, homeotype no. 2835.

### Abies laticarpus MacGinitie

(Plate 11, figure 8)

Abies laticarpus MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 47, pl. 3, fig. 5, 1933.
Oliver, Carnegie Inst. Wash. Pub. 455, p. 14, 1934.
Abies parviseminis LaMotte, Carnegie Inst. Wash. Pub. 455, p. 110, pl. 4, figs. 2-4, 1936.

Two typical seeds with attached wings form the record of Abies laticarpus in the Blue Mountains flora. As originally discussed by MacGinitie, and later by Oliver and LaMotte, they are closely similar to those produced by the living A. magnifica Murray, a typical member of the Sierra-Cascade forest commonly found at the upper margin of the yellow pine - white fir forest.

The material regarded by LaMotte as a new species, A. parviseminis LaMotte, is now synonymized with A. laticarpus. Both the scale and the seeds with their attached wings are well within the range of normal variation displayed by the modern A. magnifica, and actually resemble it more closely than they do A. lasiocarpa (Hooker) Nuttall as believed by LaMotte. Examination of the material of A. parviseminis shows that the wing of the seed is much wider distally than in any specimens of the living A. lasiocarpa. A. laticarpus is represented in the Upper Cedarville flora by a number of specimens, of which the material described as A. parviseminis resembles the smaller portions of the cones of A. laticarpus.

Occurrence. Blue Mountains, Ore.: U.C.M.P. (loc. P3936), hypotype no. 649, homeotype no. 2836. Upper Cedarville, Nev.-Cal.: U. C. M. P. (locs. P97, P115), hypotypes nos. 772, 802, 799. Trout Creek, Ore.: U. C. M. P. (loc. P275), holotype no. 555.

### Abies sonomensis Axelrod

(Plate 11, figures 6, 7)

Abies sonomensis Axelrod, Carnegie Inst. Wash. Pub. 553, p. 190, pl. 36, figs. 4, 7, 1944.
Abies parviseminis LaMotte. Smith, Amer. Mid. Naturalist, vol. 25, p. 493, pl. 2, fig. 9, 1941.
Abies laticarpa MacGinitie. Smith, ibid., p. 492, pl. 2, fig. 11, 1941.
Abies sp. cone scale Smith, ibid., p. 493, pl. 2, fig. 13, 1941.

Examination of the Thorn Creek fir material shows that all of it represents one species, and that it is well matched by seeds and cone scales of the modern Abies grandis Lindley of the Pacific Coast and northern Rocky Mountains. Smith has indicated that the specimen she identified as A. laticarpa differs from the type in having a narrower wing; it may be added that it is considerably smaller than those normally produced by the modern red fir. The Thorn Creek specimen identified as A. parviseminis LaMotte has a much shorter wing than those commonly formed by A. lasiocarpa (Hooker) Nuttall, and in this character is closer to A. grandis. The roughly rectangular cone scale is also most like those of the lowland white fir, differing from those of A. concolor Lindley and Gordon, with which Smith has compared it, in that it is wider in proportion to length; it is also smaller than the normal cone scales of A. concolor.

Two fir seeds with attached wings from the Payette flora are figured on plate 11 to illustrate the range of variation in size of A. sonomensis, which is now known from the Sonoma, Thorn Creek, and Payette floras. The larger specimen (fig. 7) is reminiscent of A. concoloroides Brown, but differs from it in having a shorter wing in proportion to the size of the seed.

Occurrence. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600). Payette, Ida.: U. C. M. P. (loc. P3743), hypotypes nos. 3245, 3246.

### Abies toxirivus new name

Abies sp. Dorf, Carnegie Inst. Wash. Pub. 476, p. 107, pl. 1, fig. 6, 1936.
Pinus steenstrupiana Heer. Penhallow, Canada Geol. Surv. Pub. 1013, p. 68, text figs. 20, 21 only, 1908.

The cone scales cited above represent a fossil fir similar to the living Abies amabilis (Douglas) Forbes.

Description. Cone scales ranging from 1.6 cm. long and 1.5 cm. wide to 2.1 (or more) cm. long and 2.5 cm. wide, broadly rounded distally, the sides gradually tapering, then sharply constricted to a narrow, long stalk at the proximal end.

Discussion. These fossil fir scales from the Lower Idaho flora and from the Quilchena flora of British Columbia, although differing somewhat from one another, are well within the range of variation of cone scales produced by the living silver fir, A. amabilis. This tree ranges from near sea level in Alaska to 5000 feet in the southern Cascades. In the northern parts of its range it often forms pure stands, but at the south it commonly is mixed with other conifers, including Abies grandis, Picea engelmannii, Pinus monticola, Pseudotsuga taxifolia, Thuja plicata, Tsuga heterophylla, and their common associates such as Acer glabrum, A. macrophyllum, Alnus tenuifolia, Cornus nuttallii, Lithocarpus densiflora, and Quercus chrysolepis. All these plants have close counterparts in the Miocene floras of the Columbia Plateau and adjacent areas.

The name toxirivus has been derived from Poison Creek, a name which was applied earlier to the lower part of the Idaho formation.

Occurrence. Lower Ida.: U.C.M.P. (loc. P635), holotype no. 1161. Quilchena, B.C.: Geol. Surv. Canada.

### *Keteleeria heterophylloides* (Berry) Brown

(Plate 11, figures 9-11)

*Keteleeria heterophylloides* (Berry) Brown, Jour. Paleontol., vol. 9, pp. 573-574, pl. 67, figs. 23, 25, 1935 (seen synonymy).

*Sciadopitys americana* Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 23, p. 225, pl. 1, fig. 1, 1938.

Keteleeria is rare in our collections, with only one specimen and its counterpart found in the Mascall flora and three in the Stinking Water. The needles are similar to those of the modern *Keteleeria davidiana* Beissner of central and southwest China. In Kweichow and Hupeh provinces it lives at elevations as low as 1500 feet in mixed woods; in Szechuan Keteleeria inhabits open slopes in hilly regions at about 3000 feet, and southwestward in Yunnan it is found in the Yangtse drainage basin in pine forests at elevations ranging from 7800 to 9000 feet.

Our material shows a somewhat greater variation in needle characters than do the Latah specimens, but we emphasize the fact that all this variation is readily matched by needles of the similar modern species. The Mascall specimen (pl. 11, fig. 11) has a twisted petiole, whereas those from Stinking Water (pl. 11, figs. 9, 10) are sharply truncated in the proximal part and are not so prominently tapered in the distal part as the Latah fossils; one of the Latah specimens, however, figured by Berry (1929, p. 240, pl. 50, fig. 2) as *Potamogeton heterophylloides*, closely approaches this type of variation.

*Keteleeria heterophylloides* has previously been known elsewhere only in the Latah flora of the Spokane area. In addition to its Mascall and Stinking Water occurrences, it is now known to be represented in the Lower Idaho, Eagle Creek, and Trout Creek floras. We have examined the specimen of *Sciadopitys americana* Smith, and it quite evidently does not have the double-needle morphology of that genus. Brown (1940, p. 355) has interpreted it as a needle of pine, but there is no doubt that it is referable to Keteleeria. The large Trout Creek collections in the Museum of Paleontology at the University of Michigan also contain several fine needles of *K. heterophylloides*.

*Occurrence*. Latah, Wash.: U. S. N. M. (Spokane loc.). Mascall, Ore.: U. C. M. P. (loc. P3735), hypotype no. 2837. Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotypes nos. 2838, 2839. Trout Creek, Ore.: U. M. M. P. Lower Idaho, Ida.: U. M. M. P.

### *Picea lahontense* MacGinitie

(Plate 12, figures 1-3)

*Picea lahontense* MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 46, pl. 3, figs. 4, 8 (not fig. 6, which is *P. magna* MacGinitie), 1933.

MacGinitie, Carnegie Inst. Wash. Pub. 599, p. 82, pl. 20, figs. 5, 6, 1953.

*Picea* sp. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 168, pl. 45, fig. 19 (not fig. 18, which is *P. sonomensis* Axelrod), 1937.

*Picea* sp. Mason, Carnegie Inst. Wash. Pub. 346, p. 151, pl. 3, fig. 2, 1927.

*Picea lahontense* is a relatively small-coned spruce which shows relationship to *P. engelmannii* Engelmann of the western United States and to *P. glauca* Voss of the eastern and northern parts of North America. Seeds in the Blue Mountains and Stinking Water floras are similar to those produced by these modern species, as is a cone in the Blue Mountains flora. Seeds in the Stinking Water flora have somewhat wider wings than those from the Blue Mountains, and seem closer to *P. glauca* than to *P. engelmannii*; further collections may show that they represent a different species.

In his original description of *P. lahontense*, MacGinitie pointed out that the large cone (1933, pl. 3, fig. 6) probably is assignable to another species. We have found in the Trout Creek collections at the University of Michigan a number of very large Picea seeds that are indistinguishable from those in the Mascall and Stinking Water floras, and are very much larger than those of either *P. lahontense* or *P. sonomensis*. With MacGinitie (1953, p. 83), we now believe that these are to be associated with the large cone originally figured as *P. lahontense*; we are assigning them to *Picea magna* MacGinitie, as indicated below. The spruce twig figured by Mason (1927) seems more properly referable to *P. lahontense* than to *P. sonomensis* on the basis of its closer resemblance to twigs of such modern species as *P. engelmannii* and *P. glauca*, and we are placing it in synonymy here.

Penhallow has described three species of spruce from British Columbia, *P. quilchenensis*, *P. tranquillensis*, and *P. columbiensis*. The first two species (Penhallow, 1908) are based on conifer needles that may well represent spruce, but they can hardly be compared with any of our species except on a generic basis. *P. columbiensis* has the same size as the cone of *P. lahontense*, but is considerably wider in its proximal part (Penhallow, 1907). The illustration is poor, and if the fossil is Picea it seems quite distinct from *P. lahontense*; there is a possibility that this cone may represent Pinus.

*Occurrence*. Blue Mountains, Ore.: U. S. N. M.; U. C. M. P. (loc. P3936), hypotypes nos. 127, 2840, 2841. Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotype no. 2842, homeotype no. 2843. Trout Creek, Ore.: U. C. M. P. (loc. P275), holotype no. 550, paratype no. 551.

### *Picea magna* MacGinitie

(Plate 12, figures 10-15)

*Picea magna* MacGinitie, Carnegie Inst. Wash. Pub. 599,

p. 83, pl. 18, figs. 5-7, 1953.

Picea lahontense MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 46, pl. 3, fig. 6 (not figs. 4, 8, which are P. lahontense MacGinitie), 1933.

Pseudotsuga masoni MacGinitie (part). Dorf, Carnegie Inst. Wash. Pub. 476, p. 107, pl. 1, fig. 3, 1936.

Picea magna, characterized by large cones and large seeds, is now known from the Florissant, Mascall, Trout Creek, Stinking Water, Blue Mountains, Thorn Creek, and Lower Idaho floras. It shows relationship to several modern species, such as P. neoveitchii Masters and P. polita Carriere of China and Japan. When more living material becomes available for comparison, it may be possible to indicate its modern relationships more precisely. In any event, it is clear that the nearest relatives of P. magna are members of the temperate deciduous and coniferous forests of eastern Asia, a region where many other modern plants are found that have close equivalents in Miocene floras of the western United States.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P28), hypotype no. 2850, homeotype no. 2851. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.). Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotypes nos. 2846, 2847, homeotypes nos. 2848, 2849. Trout Creek, Ore.: U. C. M. P. (loc. P275), lectotype no. 552, hypotype no. 2844, homeotype no. 2845. Thorn Creek, Ida.: U. C. M. P. (loc. P4600), hypotype no. 4418. Lower Idaho, Ida.: U. C. M. P. (loc. P635), hypotype no. 1158.

### Picea sonomensis Axelrod

(Plate 12, figures 4-9, 16, 17)

Picea sonomensis Axelrod, Carnegie Inst. Wash. Pub. 553, p. 190, pl. 36, fig. 2, 1944 (see discussion). Axelrod, ibid., p. 251, pl. 42, figs. 2, 3, 1944.

Pinus sp. Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 722, pl. 99, fig. 3, 1898.

Pinus spp. seeds of pine Brown, U. S. Geol. Surv. Prof. Paper 186, p. 168, pl. 45, figs. 15, 16, 1937.

Picea sp. Brown, ibid., p. 168, pl. 45, fig. 18 (not fig. 19, which is P. lahontense MacGinitie), 1937.

Picea sp. Mason. Oliver, Carnegie Inst. Wash. Pub. 455, p. 13, 1934.

Pseudotsuga masoni MacGinitie. Oliver, ibid., p. 14, 1934; Smith, Amer. Mid. Naturalist, vol. 25, p. 492, pl. 2, fig. 4 (not fig. 5, which is Pseudotsuga sonomensis Dorf), 1940.

Unidentified seed Smith, Amer. Mid. Naturalist, vol. 25, pl. 2, fig. 10, 1941.

Picea lahontense MacGinitie. Dorf, Carnegie Inst. Wash. Pub. 476, p. 107, pl. 1, fig. 2, 1936.

Supplementary description. Leafy shoots slender, terminal 10 cm. of branchlet 2.5 to 2.0 mm. wide, laterals 2.0 mm. wide; needles slender, densely clustered on shoots, apparently somewhat triangular in cross section and with a conspicuous median ridge, tips acute to obtuse, length 1.5 to over 2.5 cm., width about 1 mm.

Discussion. Picea sonomensis was a common spruce in the Miocene of the western United States, as indicated by the revised synonymy presented here. Seeds of this species have been found at a number of Miocene localities, including the Payette, Blue Mountains, Mascall, Stinking Water, Thorn Creek, Trout Creek, and Lower Idaho floras. In the Pliocene it has been recorded in the Alvord Creek flora of southern Oregon (Axelrod, 1944f) and in the Sonoma flora north of San Francisco Bay (Axelrod, 1944d). Current studies by Axelrod of Mio-Pliocene floras in west-central Nevada show that it occurs at four localities in that region.

Like many other fossil plants, Picea sonomensis shows relationship to more than one living species. In North America it is closest to P. breweriana S. Watson of the Klamath Mountain region of northern California. Here it lives in the Upper Transition zone with such species as Abies concolor, A. magnifica, Acer glabrum, A. macrophyllum, Alnus tenuifolia, A. sinuata, Amelanchier alnifolia, Arbutus menzesii, Betula fontinalis, Chamaecyparis lawsoniana, Cornus nuttallii, Lithocarpus densiflora, Mahonia aquifolium, Pinus ponderosa, P. lambertiana, Populus tremuloides, P. trichocarpa, Rosa gymnocarpa, and a number of others having close relatives in the Mascall and related floras. In eastern Asia such species as Picea asperata Masters, P. likiangensis Pritzel, and P. smithiana Beissner all show relationship to P. sonomensis. These are common forest trees in the mountains of central and southwestern China, and are found usually at elevations above 6000 feet in the upper part of the temperate forests that are closely related to those of eastern North America.

Seeds identified as Pinus steenstrupiana Heer by Penhallow (1908, p. 69, fig. 23) from the Quilchena flora of British Columbia show relationship to Picea sonomensis, and examination of these fossils may show that they represent the same or a closely related species.

Occurrence. Mascall, Ore.: U. C. M. P. (loc. P4129), hypotype no. 2855. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotypes nos. 2852, 2852a (counterpart), 2853, homeotypes nos. 646, 647, 648, 2854. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 2856, 2857. Payette, Ida.: U. S. N. M.; U. C. M. P. (loc. P3743). Trout Creek, Ore.: U. C. M. P. (loc. P275), hypotype no. 2858. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600), hypotype no. 2859. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.); U. C. M. P. (loc. P635), hypotype no. 1156, homeotypes nos. 1159, 1160.

### Pinus harneyana new species

(Plate 13, figures 1, 2)

Pinus knowltoni Chaney. MacGinitie, Carnegie Inst. Wash.

Pub. 416, p. 46, 1933.
Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 109, pl. 7, fig. 3, 1939.
Pinus sp. Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 26, pl. 8, fig. 9, 1926.
Pinus sp. Dorf, Carnegie Inst. Wash. Pub. 476, p. 106, 1936.
Pinus sp. Brooks, Ann. Carnegie Mus., vol. 24, p. 281, pl. 4, figs. 2, 3 only, 1935.
Pseudotsuga masoni MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 47, pl. 3, figs. 1-3, 1933.

Description. Needles in threes, medium thick to medium, slightly curving or straight, from 5 to 15 cm. long (estimated); sheath apparently somewhat deciduous, not clasping the needles (though it may have been worn away). Seeds with elliptical-obovate wings averaging 1.4 cm. long and 6 mm. wide, oval and somewhat pointed proximad, dimensions 5 by 3 mm.

Discussion. Foliage and seeds of Pinus are well represented in the Mascall and Stinking Water floras. Several other incomplete records, as listed above, indicate a 3-needled pine of the same kind. Rather than use the name Pinus knowltoni, assigned to specimens from the Eagle Creek flora which are at least in part of doubtful status and may not represent Pinus, we are setting up a new species for this material from the Miocene of the Columbia Plateau. Included in it are seeds identified as Pseudotsuga masoni from the Trout Creek flora; our basis for referring them to Pinus is their rounded rather than sharply angled shape at the point of attachment to the wing, and their rounded wing-tips which in modern species of Pseudotsuga are acute. Pinus harneyana shows some resemblance to P. florissanti, and may prove to be a derivative of this Oligocene pine from Colorado.

The relationship of P. harneyana to living pines is not clear. It seems to represent a yellow pine, and the best match we have been able to find is P. ponderosa Lawson and its varieties, such as scopulorum and brachypterum; there are sufficient differences to suggest that we are dealing with an extinct species of the yellow pine group. Such species as P. taeda Linnaeus and P. rigida Miller show more distant relationship.

Occurrence: Mascall, Ore.: U. C. M. P. (locs. P28, P3735), hypotypes nos. 2860, 2861, homeotypes nos. 2862, 2863. Stinking Water, Ore.: U. C. M. P. (loc. P4120), homeotypes nos. 4419, 4420. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), lectotype no. 553, syntype no. 545, homeotypes nos. 548, 549. Lower Idaho, Ida.: U. C. M. P. (loc. P636), homeotype no. 1155. Succor Creek, Ida.: Carnegie Mus. Latah, Wash.: U. S. N.M. (Spokane loc.).

### Pinus tiptoniana new species

(Plate 13, figures 3-7)

Pinus knowltoni Chaney. Mason, Carnegie Inst. Wash. Pub. 346, p. 148, pl. 3, figs. 6, 7, 1927.
Oliver, Carnegie Inst. Wash. Pub. 455, p. 13, 1934.
Pinus spp. needles Brown, U. S. Geol. Surv. Prof. Paper 186, p. 167, pl. 45, fig. 13, 1937.
Pinus spp. seeds of pine Brown, ibid., p. 168, pl. 45, figs. 14, 17, 20, 1937.

Description. Fascicles of 2 needles, averaging over 8 cm. long and about 1.3 mm. wide; sheath apparently deciduous. Mature cones long-oval, about 8 cm. long and 3.0 to 3.5 cm. wide, apparently somewhat asymmetrically developed but not greatly so; cone scales flattened distally and relatively thin; umbo small and generally suppressed, though sometimes of moderate size, and placed from 4.0 to 6.0 mm. in from tip of scale; prominent ridge sometimes extending to edges of scale from the umbo.

Seeds long-oval to oval, somewhat asymmetrically acute at distal end, the lower surface concave and the upper straight to slightly concave, tip blunt, rounded where attached to wing, the mature seeds 5 to 8.5 mm. long and 3.0 to 4.0 mm. wide; wing 1.3 to 1.9 cm. long, generally slender and varying from essentially uniform in width to somewhat wider in the distal part, rounded distally.

Discussion. A large suite of Pinus tiptoniana material is represented in the Blue Mountains flora by ovulate and staminate cones, 2-needled fascicles,[1] and seeds. By studying positive casts of cone impressions it has been possible to show that this pine is not a member of the California closed-cone pine group, as previously suggested by Mason and Oliver, but that it finds closer relationship with European species of the Insignes group. The cones of P. tiptoniana more nearly resemble those of the modern Aleppo pine, P. halepensis Miller, of southern Europe than any other species studied. P. halepensis has a close counterpart in P. hageni Heer (1869, pl. 1, figs. 23-33), which has been recorded from the Miocene floras of Austria, Jugoslavia, France, and central Germany. In those floras it is associated commonly with members of the Arcto-Tertiary Geoflora, including species of Acer, Alnus, Betula, Carpinus, Cercidiphyllum, Fagus, Glyptostrobus, Populus, Quercus, Salix, Sassafras, Sequoia, Smilax, Taxodium, and Ulmus that are closely similar to Miocene species in the Mascall and related floras in the western United States. Although the cones of P. tiptoniana are very similar to those of P. halepensis, the needles of P. tiptoniana are not so slender as those of the Aleppo pine. In this respect P. tiptoniana is perhaps more nearly related to

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[1] Mason (1927, p. 148) and Oliver (1934, p. 13) both report a 3-needled fascicle in the Blue Mountains collection, but we have not been able to find this specimen. On the basis of over 50 2-needled fascicles examined in the flora, we conclude that P. tiptoniana was a 2-needled species; some species occasionally vary in the number of needles, and it is possible that P. tiptoniana may occasionally have produced a fascicle of 3 needles.

P. nigra Arnold of southeastern Europe and western Asia, yet the cones of that species average somewhat smaller than P. tiptoniana, and the shape of the umbos differs. The cones of two species living in the eastern United States, P. echinata Miller and P. resinosa Aiton, have somewhat smaller cones, but their needles are similar to P. tiptoniana and a resemblance is apparent, especially to the former.

Occurrence. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.), U. C. M. P. (locs. P3936, P3937), lectotype no. 129, paratypes nos. 128, 645, 2866, 2867, 2869, homeotypes nos. 642, 643, 644, 2868, 2870, 2871.

### Pinus wheeleri Cockerell

Pinus wheeleri Cockerell, Bull. Amer. Mus. Nat. Hist., vol. 24, p. 78, pl. 5, figs. 5, 11, 1908.
MacGinitie, Carnegie Inst. Wash. Pub. 599, p. 85, pl. 18, figs. 9-11, 13, 1953.
Pinus tulameenensis Penhallow, Canada Geol. Surv. Pub. 1013, p. 73, text fig. 34, 1908.
Pinus trunculus Dawson. Penhallow, ibid., p. 71, fig. 24, 1908.
Pinus tetrafolia Berry, U. S. Geol. Surv. Prof. Paper 154, p. 238, pl. 49, fig. 6, 1929.
Dorf, Carnegie Inst. Wash. Pub. 476, p. 106, 1936.
Pinus monticolensis Berry, U. S. Geol. Surv. Prof. Paper 154, p. 238, pl. 49, figs. 5, 8, 1929.
Berry, U. S. Geol. Surv. Prof. Paper 185, p. 104, 1934.
Pinus latahensis Berry, U. S. Geol. Surv. Prof. Paper 154, p. 238, pl. 49, fig. 7, 1929.
Pinus knowltoni Chaney. Dorf, Carnegie Inst. Wash. Pub. 476, p. 106, 1936.
Pinus quinifolia Smith, Amer. Mid. Naturalist, vol. 25, p. 490, pl. 2, figs. 2, 8, 1941.
Pinus russelli LaMotte, Carnegie Inst. Wash. Pub. 455, p. 110, pl. 5, figs. 2, 3, 1936.
Pinus spp. seeds of pine Brown, U. S. Geol. Surv. Prof. Paper 186, p. 168, pl. 45, fig. 26, 1937.

Among American fossil conifers, members of the genus Pinus are probably the most difficult to evaluate. This is due largely to the fragmentary nature of much of the material. Fascicles, for example, often have missing needles, so that the number per bundle cannot easily be determined. In the case of seeds, allocation to species is hampered by the fact that modern seeds are not always available for comparison, and the fossil specimens in many cases represent immature seeds which are difficult to determine. For these and other reasons, it is only natural that fossil species of pine have been greatly overmultiplied; also a large amount of material has been referred only to the genus, because of the incomplete nature of the fossils. It is obvious that until someone can assemble all fossil pine material and completely revise the described species, further duplication of species will occur.

In our study of the fossil pines represented in the Miocene floras of the far West we have found 8 described species of white pine that are sufficiently alike so that they can be grouped together at least into a generalized species. These include the species listed above from the Florissant, Tulameen, Republic, Latah, Upper Cedarville, Lower Idaho, and Thorn Creek floras. Since they all show relationship to such living species as Pinus monticola Douglas and P. strobus Linnaeus, it seems best to consider them, at least tentatively, as one biologic entity rather than as 8 different species of white pine.

The seeds of P. russelli LaMotte have been considered to represent Cedrela (Brown, 1937, p. 179). Examination of the specimens demonstrates that the figures are misleading as to the character of the fossils. They clearly represent the seeds of white pine; they do not have either the typical marginal spine or the crease on the upper half of the distal part of the wing that distinguish the seeds of Cedrela.

Occurrence. Florissant, Colo.: U. S. N. M.; U. C. M. P., hypotypes nos. 3773, 3774, 3775. Republic, Wash.: U. S. N. M. Latah, Wash.: U. S. N. M. (Spokane loc.). Upper Cedarville, Cal.-Nev.: U. C. M. P. (locs. P97, P115), holotype no. 779, paratype no. 780. Lower Idaho, Ida.: U. C. M. P. (loc. P635), homeotype no. 1145. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600).

### Pseudotsuga sonomensis Dorf

(Plate 13, figures 13-15)

Pseudotsuga sonomensis Dorf, Carnegie Inst. Wash. Pub. 412, p. 72, pl. 6, figs. 2-4, 1930.
Axelrod, Carnegie Inst. Wash. Pub. 553, p. 191, pl. 36, fig. 3, 1944.
Axelrod, ibid., p. 251, pl. 42, fig. 1, 1944.
Pseudotsuga taxifolioides Arnold, Jour. Wash. Acad. Sci., vol. 25, p. 378, text fig. 1, 1935.
Pseudotsuga masoni MacGinitie. Smith, Amer. Mid. Naturalist, vol. 25, p. 492, pl. 2, fig. 5 only, 1941.

An excellent specimen representing the terminal part of a twig of Pseudotsuga is in our Blue Mountains collection, and a cone impression of a fossil Douglas fir is in the Blue Mountains material at the U. S. National Museum. The cone and the blunt needles, which are characterized by a prominent groove extending to the apex, can be matched exactly by equivalent material from the modern Pseudotsuga taxifolia (Poiret) Britton. This is a widely distributed tree in western North America, ranging from Alaska southward into central California, and southeastward along the Rocky Mountain axis into northern Mexico.

The synonymy presented above includes all known authentic records of Pseudotsuga of the taxifolia type in the Miocene and Pliocene of western North America. The cone figured by Arnold from Trout Creek differs in no fundamental way from the Sonoma types. The cones from the Sonoma tuff are open, because of their subaerial deposition, whereas the Trout Creek cone, occurring in diatomite deposits of a lake, is closed. A number of seeds have been referred by various authors to P. masoni MacGinitie, but most of these have proved to represent Pinus or Picea. Pseudotsuga masoni MacGinitie from Trout Creek represents Pinus. The seeds are round-oval and not sharply acute at the upper point of attachment with the wing as in Pseudotsuga; another difference is that the wings are rounded distally, rather than acute. We believe that these seeds are to be associated with the short, 3-needled pine fascicles that have been identified in that flora as Pinus knowltoni Chaney (MacGinitie, 1933, p. 46), and which appear to be identical with those described as Pinus harneyana Chaney and Axelrod from the Mascall and Stinking Water floras.

Pseudotsuga has thus been recognized in the Blue Mountains, Trout Creek, and Thorn Creek floras of the Columbia Plateau region, all floras of distinctly upland aspect. It survived in this area into the early Pliocene, where it is recorded at Alvord Creek (Axelrod, 1944f).

Occurrence. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.), hypotype; U. C. M. P. (loc. P3936), hypotype no. 2872. Trout Creek, Ore.: U. M. M. P. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600), hypotype no. 2873.

### Tsuga sonomensis Axelrod

(Plate 13, figures 8-12)

Tsuga sonomensis Axelrod, Carnegie Inst. Wash. Pub. 553, p. 192, pl. 36, figs. 5, 6, 1944.

Taxus sp. Mason. Oliver, Carnegie Inst. Wash. Pub. 455, p. 16, 1934.

Picea cones of Brown, U. S. Geol. Surv. Prof. Paper 186, p. 167, pl. 45, figs. 29, 30, 1937.

Supplementary description. Leafy branchlets of year's growth 2.5 to 5.0 cm. long, slender, 1.0 to 1.3 mm. wide, with conspicuous leaf scars; needles of variable size on the twigs, 0.4 to 2.0 cm. long, tips blunt and rounded, not conspicuously grooved, attached to twig by a twisted petiole. Small, oval staminate cones in axils of needles near apex of twig.

Discussion. Tusga has been recognized previously in only one other Tertiary flora of North America. The record of T. sonomensis is based on characteristic seeds in the Upper Pliocene Sonoma flora north of San Francisco Bay (Axelrod, 1944d). We are provisionally recognizing our Blue Mountains species as Tsuga sonomensis on the basis of seed similarity. Seeds of Tsuga are readily identifiable by being widest near the middle of the wing, and the wing characteristically extends under the lower edge of the seed, rather than being attached to the end of the seed as in pine and spruce. The hemlock material in both the Blue Mountains and Sonoma floras is closely matched by the modern T. heterophylla Sargent, ranging from southeastern Alaska to coast-central California and extending eastward to Idaho and Montana. In examining our large collections of Miocene floras in the University of California Museum of Paleontology, we have discovered seeds of T. sonomensis in the Trout Creek and Thorn Creek floras; these are illustrated on plate 13.

The material identified by Oliver (1934) as Taxus sp. Mason represents Tsuga. After the specimen was cleaned, it became evident that the blunt to rounded needles are of varying length like our other specimens from this locality.

Occurrence. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (loc. P3937), hypotypes nos. 2909, 2910, 2911, homeotype no. 658. Trout Creek, Ore.: U. C. M. P. (loc. P275), hypotype no. 2912. Thorn Creek, Ida.: U. C. M. P. (loc. P4600), hypotype no. 2913.

### Conifer of uncertain affinity

(Plate 14, figure 9)

Description. Branch and shoots of year's growth stout, 3.5 to 4 mm. wide in distal parts, with spirally arranged, awl-shaped, stiff needles; needles 0.7 to 3.3 cm. long and 1 to 2 mm. wide, with a sharp spine; truncated below, the point of attachment to the twig not clear, but apparently twisted. Young ovulate cone oblong in outline, rounded in distal part, truncated proximally; 2.7 cm. wide and 3.4 cm. long; cone scales arranged spirally, approximately 7 across mid-line of cone; scale tips forming equidimensional rhomboidal scars 2 to 3 mm. wide and long; umbos slightly hooked, 2 to 3 mm. long.

Discussion. Interpretation of this fossil and its counterpart is particularly difficult because it appears to be unique in the fossil record, and because there is no living conifer that combines all the features shown by our specimen. The basic point of departure for interpretation of this material rests on the decision as to whether the cone is actually attached to the foliage shoot. If it could be demonstrated conclusively that the cone is not attached, then it could well be regarded as a young cone of Pinus tiptoniana, a common species in the flora. That the cone most probably represents Pinus is shown by comparison with immature cones of living pines: the prickles on the umbos are characteristic, as are the rhomboidal scars on the scales. If it is assumed that two unrelated plants are here represented, the foliage shoot can readily be identified as Abies chaneyi, which has been recorded in the near-by Mascall and Stinking Water floras; somewhat less resemblance is apparent to the young branchlets of Keteleeria heterophylloides.

Nevertheless, a careful examination of this specimen and its counterpart over a period of years, by the authors and others, brings us to the conclusion that the cone and the foliage shoot are in attachment. The possibility arises that a new genus of conifer is represented, since no known living or fossil member of the Pinaceae has both leaves and cones of this type. We are reluctant to describe a new genus, since there is but a single specimen and its counterpart. Future collections may provide additional material which may indicate more precisely the systematic position of this fossil. It is evident that the discovery of unique conifer seeds at Tipton would strengthen the case for a new conifer.

Occurrence. Blue Mountains, Ore.: U. C. M. P. (loc. P3936), nos. 2895, 2895a.

## Family TAXODIACEAE

### Glyptostrobus oregonensis Brown

(Plate 14, figure 5; plate 15, figure 6;
plate 16, figures 3-7)

Glyptostrobus oregonensis Brown, Jour. Wash. Acad. Sci., vol. 26, p. 353, text fig. 1, 1936 (see synonymy).
Glyptostrobus europaeus Lesquereux. Smith, Papers Mich. Acad. Arts, Sci. and Letters, vol. 24, p. 109, pl. 1, fig. 14, 1939.
Sequoia langsdorfii (Brongniart) Heer. Dorf, Carnegie Inst. Wash. Pub. 476, p. 108 (part), 1936.
Smith, Papers Mich. Acad. Arts, Sci. and Letters, vol. 24, p. 109, pl. 5, fig. 1, 1939.
LaMotte, Carnegie Inst. Wash. Pub. 455, p. 111, 1936.
Lycopodium prominens Lesquereux. LaMotte, ibid., p. 142, pl. 3, fig. 1, 1936.
Juniperus sabinoides Ashlee. Dorf, Carnegie Inst. Wash. Pub. 476, p. 109, 1936.

Deciduous branchlets representing foliar and reproductive material of Glyptostrobus are exceedingly common in the Stinking Water flora and illustrate especially well the variation displayed by this species. The representative material figured on plates 14, 15, and 16 shows that in its reproductive structures Glyptostrobus oregonensis differs from the European G. europaeus (Brongniart) Heer in two important respects, as pointed out by Brown. In the first place, the American species has pyriform cones rather than the more oval cones of G. europaeus; secondly, the tips of the cone scales in G. oregonensis are not strongly crenulated like those of the European species. The foliar material cannot be separated with certainty from that of G. europaeus, but it nonetheless is desirable to keep the American species distinct in view of the easily recognizable differences in the cones. Most of our foliar material represents the cupressoid type of deciduous branchlets, but there also are some of the thuyoid type. Several specimens of the taxodioid type in the collections might well have been referred to Taxodium had they been collected without accompanying cone material. Similar foliage in the Mascall flora has been recorded by Lesquereux (1888, p. 19) and Knowlton (1902, p. 26) as Glyptostrobus. In view of the absence of any fruiting material of Glyptostrobus in that flora, and the common presence there of Taxodium staminate aments, we are assigning the Mascall material to Taxodium, one of the dominants of the flora.

Occurrence. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 2881-2888 incl. Succor Creek, Ore.: U. S. N. M.; U. C. M. P. (locs. P3742, P3745, P3747); U. M. M. P.; Carnegie Mus. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.); U. C. M. P. (loc. P635), homeotypes nos. 1162, 1169, 1170, 1171. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotype no. 771, homeotype no. 830.

### Metasequoia occidentalis (Newberry) Chaney

(Plate 15, figures 2, 4)

Metasequoia occidentalis (Newberry) Chaney, Trans. Amer. Phil. Soc., vol. 40, p. 225, pl. 1, fig. 3; pl. 2, figs. 1-3; pl. 4, figs. 1, 2, 9; pl. 5, figs. 1-3; pl. 6, fig. 2; pl. 7, figs. 1-6; pl. 8, figs. 1-3; pl. 9, figs. 3, 5-7; pl. 10, figs. 1a, 2a, 3-6; pl. 11, figs. 7, 8; pl. 12, figs. 1, 2, 5-8, 1951 (see synonymy and discussion).

Foliage shoots with the decussately attached needles of Metasequoia are not uncommon in the Mascall flora, and a few cones bearing the naked, long stalks so characteristic of the genus are also in the collections. Metasequoia occidentalis was a dominant member of many Tertiary floras, ranging in age from the Paleocene into the Middle Miocene in North America. During this time it ranged geographically from northern Alaska southward to California and eastward to the MacKenzie Basin and North Dakota. Scarcely distinguishable species occur also in northeastern Asia, Spitzbergen, and Greenland in the Early Tertiary, and in the middle latitudes of eastern Asia in the Late Tertiary. This deciduous conifer was associated regularly with temperate deciduous trees throughout most of its history. Only at its more southerly stations is it recorded with warm-temperate evergreens. Similar relations are apparent in its present occurrence.

The Mascall record of Metasequoia represents the last known occurrence of the genus in North America.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735, P4123, P4129), hypotypes nos. O. S. 855, 2889, 2891, 3534, homeotypes nos. 2890, 2892, 2893, 2902.

### Sequoia affinis Lesquereux

(Plate 15, figures 3, 5, 7, 9)

Sequoia affinis Lesquereux, Rept. U. S. Geol. Surv. Terr., vol. 7, p. 75, pl. 7, figs. 3-5; pl. 65, figs. 1-4, 1878.
Chaney, Trans. Amer. Phil. Soc., vol. 40, p. 231, pl. 1, fig. 2; pl. 3, figs. 2-4; pl. 4, figs. 3, 4, 7; pl. 6, fig. 6; pl. 7, figs. 7-9, 12; pl. 8, fig. 10; pl. 12, figs. 3, 4, 1951 (see synonymy and discussion).
MacGinitie, Carnegie Inst. Wash. Pub. 599, p. 85, pl. 16, figs. 1-3; pl. 17, fig. 1, 1953.
Torreya bonseri (Knowlton) LaMotte. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 167, pl. 45, fig. 22, 1937.

Sequoia affinis is a common member of the Blue Mountains flora, where it is represented by characteristic branchlets and by cones attached to stalks bearing small scale leaves. Sequoia affinis has not been found in the Mascall and Stinking Water floras, which are dominated by Taxodium and Glyptostrobus, respectively. The occurrence of different taxodiaceous dominants in these floras finds an explanation in the ecological occurrence of their modern counterparts. Taxodium is indicative of swampy habitats chiefly, Glyptostrobus occurs in lowland areas largely in well drained sites bordering streams or lakes, and Sequoia does not occur in areas subject to flooding, but in lowland sites is always on well drained terraces along river valleys.

Occurrence. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotypes nos. 650, 654, 2899, 2900, 3530, 3531, homeotypes nos. 651, 652, 653. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600).

### Taxodium dubium (Sternberg) Heer

(Plate 15, figures 1, 8)

Taxodium dubium (Sternberg) Heer, Flora Tert. Helv., vol. 1, p. 49, pl. 17, figs. 5-17, 1855.
Chaney, Trans. Amer. Phil. Soc., vol. 40, p. 233, pl. 1, fig. 1; pl. 3, fig. 1; pl. 4, figs. 5, 6; pl. 6, fig. 4; pl. 7, fig. 11; pl. 8, figs. 4, 6-9; pl. 9, figs. 1, 2; pl. 10, figs. 1b, 2b; pl. 11, fig. 9; pl. 12, fig. 9, 1951 (see synonymy and discussion).
Taxodium distichum miocenicum Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 19, 1888.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 27, 1902.
Taxodium, male aments of, Knowlton, U. S. Geol. Surv. Bull. 204, p. 27, pl. 1, figs. 4, 6, 1902.
Taxodium nevadensis Lesquereux. Mason, Carnegie Inst. Wash. Pub. 346, p. 154, pl. 5, figs. 2, 5, 6, 1927.
Glyptostrobus europaeus (Brongniart) Heer. Berry, U. S. Geol. Surv. Prof. Paper 170, p. 34, 1931.
Glyptostrobus ungeri Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 19, 1888.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 26, 1902.
Sequoia angustifolia Lesquereux. Knowlton, ibid., p. 24, 1902.
Sequoia langsdorfii (Brongniart) Heer. Knowlton, ibid., p. 25 (part), 1902.
Dorf, Carnegie Inst. Wash. Pub. 476, p. 108 (part), 1936.
Berry, U. S. Geol. Surv. Prof. Paper 170, p. 34, 1931.
Berry, U. S. Geol. Surv. Prof. Paper 185, p. 104, 1934.
Sequoia nordenskioldii Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 19, 1888.
Lycopodium prominens Lesquereux, Rept. U. S. Geol. Surv. Terr., vol. 7, p. 45, pl. 5, fig. 13, 1878.

Foliage of Taxodium is abundant at all Mascall localities, and staminate aments are represented commonly, but we have found no pistillate cones or cone-scales here.

Although swamp-cypress is not known from many middle and late Tertiary localities in the Far West, it is noteworthy that it is a dominant member of the Mascall, Latah, Elko, Weaverville, and Neroly (Loma Ranch) floras. The living T. distichum (Linnaeus) Richard has its greatest abundance on lake and swamp borders at low elevations, where it contributes numerous foliage shoots and reproductive structures to contemporary sediments. The great size of the trees, their deciduous habit, and their occurrence in pure stands also appear to have been factors which made T. dubium abundant at several Tertiary localities.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (all locs.), hypotypes nos. 140, 141, 142, O.S. 889, O.S. 1800, 2894, 2901, 2903-2905, 3523, 3526, 3532, 3538, 3545, 3546, homeotypes nos. O.S. 863, O.S. 872-882. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird, Coeur d'Alene locs.). Payette, Ida.: U. S. N. M.; U. C. M. P. (loc. P3743). Lower Idaho, Ida.: U. S. N. M. (Alkali Creek loc.); U. C. M. P. (loc. P638), homeotype no. 1163.

## Family CUPRESSACEAE

### Chamaecyparis linguaefolia (Lesquereux) MacGinitie

Chamaecyparis linguaefolia (Lesquereux) MacGinitie, Carnegie Inst. Wash. Pub. 599, p. 89, pl. 21, figs. 1-6, 1953 (see synonymy).
Thuites sp. Knowlton. MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 48, pl. 3, fig. 7, 1933.
Chamaecyparis gracilis Condit, Carnegie Inst. Wash. Pub. 553, p. 39, pl. 4, fig. 2, 1944.
Chaney, Carnegie Inst. Wash. Pub. 553, p. 340, pl. 57, fig. 3, 1944.

The only records of Chamaecyparis that are now known from floras of post-Florissant age in the far West are those at Trout Creek in southeastern Oregon (MacGinitie, 1933), Remington Hill in the central Sierra Nevada (Condit, 1944a), Hog Creek, Idaho (U. S. N. M. coll.), and Troutdale in northern Oregon (Chaney, 1944c). These fossils are referred to the Florissant species since they cannot be separated on the basis of the morphological evidence now in hand. All this material shows relationship to Chamaecyparis lawsoniana Parlatore of northwestern California and adjacent Oregon. This tree is commonly coastal in occurrence, but reaches inland along coastal valleys and has a relict occurrence on Mount Shasta. Many of its associates have close relatives in Miocene floras of the Columbia Plateau, including Abies concolor, A. grandis, Acer glabrum, A. macrophyllum, Alnus rhombifolia, A. tenuifolia, Cornus californica, Fraxinus oregona, Gaultheria shallon, Lithocarpus densiflora, Mahonia aquifolium, M. repens, Pinus monticola, Quercus chrysolepis, Q. garryana, Q. kelloggii, Salix scouleriana, Sequoia sempervirens, and Thuja plicata.

Occurrence. Trout Creek, Ore.: U. C. M. P. (loc. P275), hypotype no. 557. Remington Hill, Cal.: U. C. M. P. (loc. P3935), hypotype no. 2381. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.).

### Fokienia praedecurrens (Knowlton) new combination

(Plate 14, figure 8)

Libocedrus praedecurrens Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 28, pl. 8, fig. 8, 1926.
Berry, U. S. Geol. Surv. Prof. Paper 170, p. 34, 1931.
Thujopsis gracilis Heer. Jennings, Mem. Carnegie Mus., vol. 8, p. 403, pl. 23, fig. 5, 1920.
Thuja garmani Lesquereux. Dorf, Carnegie Inst. Wash. Pub. 476, p. 109, pl. 1, fig. 1, 1936.
Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 23, pl. 1, fig. 11, 1938.
Scale Chaney, Contr. Walker Mus., vol. 2, p. 181, pl. 22, fig. 5, 1920.

All the specimens cited above represent the same plant, and similar material from the Lower Miocene Molalla flora of northern Oregon is illustrated on plate 14. We assign this conifer to Fokienia rather than Libocedrus or Thuja because the scale leaves at each node are of equal size, they are large, they do not extend down the twig to form long internodes, and they may be so disposed as to form 3-ranked twigs. We find that this material is indistinguishable from branchlets of the modern Fokienia hodginsii Dunn, a tree endemic to Fukien province of the coastal region of southeastern China. It may be recalled that there are several other plants in the Miocene floras of the western United States that have their nearest modern counterparts in this region. Among these may be mentioned Glyptostrobus oregonensis, Laurophyllum merrilli, and Lindera oregoniana, all members of warm-temperate associations analogous to the Taxodium community of the Gulf region of the southern United States.

Occurrence. Molalla, Ore.: U. C. M. P. (loc. P3919), hypotype no. 4421. Latah, Wash.: U. S. N. M. (Spokane, Grand Coulee locs.). Eagle Creek, Ore.: Walker Mus. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.); U. C. M. P. (loc. P635), hypotype no. 1167; U. M. M. P. (Hog Creek loc.). Missoula, Mont.: Carnegie Mus.

### Libocedrus masoni new name

(Plate 14, figures 6, 7)

Libocedrus decurrens Torrey. Mason, Carnegie Inst. Wash. Pub. 346, p. 155, pl. 5, figs. 3, 7, 9-11, 1927.
Libocedrus sp. Dorf, Carnegie Inst. Wash. Pub. 412, p. 73, pl. 6, fig. 8, 1930.

The presence of incense cedar in the Mascall flora is well documented by leafy twigs, cones, and seeds. This material cannot be assigned to any of the five Tertiary species previously placed in Libocedrus for the following reasons: (1) Libocedrus coloradensis (Cockerell) Cockerell is considered by MacGinitie to represent Chamaecyparis linguaefolia (Lesquereux) MacGinitie (1953, p. 89); (2) L. dimorpha Oliver is referred to Thuja dimorpha below; (3) L. praedecurrens Knowlton, as discussed above, is referred to Fokienia praedecurrens; (4) the wide difference in age and geographic occurrence of L. sabiniana Heer makes any attempt to establish its specific identity with our specimens difficult, though a close resemblance of the foliage is apparent; (5) Mason identified the Mascall material as L. decurrens, but it is not sufficiently complete to justify this reference to the living incense cedar of the Sierra-Cascade forests, nor is such a reference consistent with acceptable paleobotanical procedure. We are therefore designating it as a new species.

As originally indicated by Mason, the Mascall species closely resembles the living L. decurrens Torrey, a characteristic tree of the middle Sierra-Cascade forest, ranging from southern Oregon into southern California. Its common occurrence in the modern forest makes it difficult to understand why L. masoni was such a rare forest tree near sites of deposition in the Columbia Plateau and northern Great Basin areas during the Middle Tertiary. Perhaps at that time it was generally confined to more distant slopes away from the lake basins in which most of the Miocene floras accumulated. Its absence from the Trout Creek, Blue Mountains, and Thorn Creek floras, however, makes this suggestion somewhat less tenable, for these floras all accumulated at higher elevations and include numerous conifers and other species which are similar to trees associated with Libocedrus today.

With respect to other material previously recorded as Libocedrus in the far West, the seed impressions assigned to this genus from the Lower Idaho flora (Dorf, 1936) are now considered to be Cedrela (Brown, 1937a, p. 179). However, the Libocedrus branchlet recorded by Dorf (1930) from the Pliocene of California apparently represents the same species as the Mascall, and we are placing it in synonymy under L. masoni.

We take pleasure in naming this species for Professor Herbert L. Mason, who originally determined it, and who has been of material assistance in our study of the Mascall conifers.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P28), syntypes nos. 145, 146, 149, paratypes nos. 147, 148, 2874, 2875. Santa Clara, Cal.: U.C.M.P. (loc. 160), syntype no. 321, paratype no. 322.

### Thuja dimorpha (Oliver) new combination

(Plate 14, figures 1-4)

Libocedrus dimorpha Oliver, Carnegie Inst. Wash. Pub. 455, p. 15, pl. 3, fig. 1, 1934.
Thuites sp. Knowlton, U. S. Geol. Surv. Bull. 204, p. 26, pl. 1, fig. 3, 1902.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 168, pl. 45, figs. 6, 7, 1937.
Thuja garmani Lesquereux. Mason, Carnegie Inst. Wash. Pub. 346, p. 155, 1927.
Smith, Amer. Mid. Naturalist, vol. 25, p. 493, pl. 2, fig. 7, 1941.
Sabina linguaefolia (Lesquereux) Cockerell. Jennings, Mem. Carnegie Mus., vol. 8, p. 404, pl. 23, fig. 2, 1920.
Chamaecyparis gilmoreae LaMotte, Carnegie Inst. Wash. Pub. 455, p. 112, pl. 3, fig. 5 only, 1936.

It is necessary to use the name dimorpha rather than garmani for this material because Thuja garmani Lesquereux (1873b, p. 372) is known only from a very poor description. The specimen is not in the collections at the U. S. National Museum, and we have not encountered any Thuja-like material in our large collections from the Elko localities. Since the fossil has never been figured, and is now lost, it seems best to consider T. garmani a nomen dubium.

The specimens from the Mascall, Blue Mountains, Latah, Republic, and Upper Cedarville floras listed above are sufficiently alike to be grouped together into one species. All the material shows relationship to such living species as T. plicata D. Don of the northwest Pacific coast and to T. orientalis Linnaeus of China and Japan.

The fact that some of the fossil branchlets are larger than others is not considered significant, for we find a gradation between them, and one modern species, orientalis, produces branchlets of both sizes. Oliver considered the Blue Mountains material to represent Libocedrus on the basis of the morphology of the main branchlets, although she has indicated that the arrangement of the needles of the young branchlets is indistinguishable from that in such species as T. plicata. The main branchlets of Libocedrus have long scale leaves, and both the lateral and medial rows have their apex on the same plane. In Thuja, on the other hand, scale leaves of the medial row often are shorter than the laterals and may reach only half as far up on the stem. We have re-examined the types of L. dimorpha, as well as our supplementary material, under a microscope and find that the scale leaves of the medial row on the older branchlets are placed slightly above the laterals, not even with them as in Libocedrus. We consider this a significant point, for the same relationship may exist in the modern T. orientalis (see sheet 357776 in U. C. Herbarium). This feature, coupled with the indisputable Thuja morphology of the younger branchlets, leads us to the conclusion that L. dimorpha Oliver is properly referable to Thuja, not to Libocedrus.

All the younger branchlets differ from those of Libocedrus in having shorter scale leaves, and these also differ in arrangement. In Libocedrus the lateral needle leaves do not join along the medial row of leaves as in Thuja and in the fossils, but are free nearly to the base; this results in a nearly equal area for all the needles. In Thuja the medial row is partly covered by the laterals, so that a much smaller area is exposed than in Libocedrus. Also the scale leaves of Thuja are more acute than those of Libocedrus. The fossil material is readily distinguished from Chamaecyparis by difference in needle arrangement, and by the greater size of the fossils. In Thuja the lateral scale leaves are free well toward the base, so that each needle of the medial row reaches up into the notch formed by the two laterals and overlaps the scale leaf above. In Chamaecyparis, on the other hand, the lateral scale leaves of each whorl join in the upper half. The result is that the apex of each scale leaf of the medial row is regularly below the point of juncture of the two laterals, and thus does not overlap the medial scale leaf above.

We have examined the specimens of Thuites sp. Knowlton from the Latah and Republic floras (Brown, 1937), and find they are indistinguishable from the Mascall and Blue Mountains material. The small branchlets of Thuites sp. Knowlton from Trout Creek (MacGinitie, 1933), on the other hand, differ from our typical Thuja specimens in having smaller scale leaves and a resultant delicate aspect. MacGinitie originally pointed out that these specimens show closer resemblance to Chamaecyparis than to Thuja, and we are in agreement with him. The Trout Creek material is therefore transferred to Chamaecyparis linguaefolia (Lesquereux) MacGinitie. We find, however, that there are several fine specimens of T. dimorpha in the large Trout Creek collections at the University of Michigan.

The paratype of Chamaecyparis gilmoreae LaMotte (1936, pl. 3, fig. 5) differs considerably from C. nootkatensis (Lambert) Spach, to which it has been likened. This modern species has scale leaves that are smaller than the fossils, and differ from them in being awl-like. The leafy twig from the Upper Cedarville flora is of the size of Thuja and agrees with it in morphology, and we therefore transfer it to T. dimorpha. LaMotte reports that the cone impression which is the type of C. gilmoreae (1936, pl. 3, fig. 4) has striations similar to those found on cones of C. nootkatensis. Examination of the specimen shows that this is not the case; the striations of the cone scales are circumferential, not parallel to the axis of the scale as in the modern species. Since it is possible that this specimen may represent some sort of artifact, we consider it advisable to place it in incertae sedis until its status is determined.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P28, hypotypes nos. 2876, 2878, 2879, homeotype no. 2880. Blue Mountains, Ore.: U. C. M. P. (locs. P3936, P3937), holotype no. 655, hypotype no. 2877, homeotypes nos. 656, 657. Latah, Wash.: U. S. N. M. (Spokane loc.). Republic, Wash.: U. S. N. M. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.); U. M. M. P. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600). Trout Creek, Ore.: U. M. M. P. Upper Cedarville, Cal.-Nev.: U. C. M. P. (locs. P97, P115), hypotype no. 774.

## Family TYPHACEAE

### Typha lesquereuxi Cockerell

Typha lesquereuxi Cockerell, Bull. Torrey Bot. Club, vol. 33, p. 307, 1906.
Phragmites oeningensis Al. Braun, Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 19, 1888.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 27, 1902.
Cyperacites sp. Knowlton, ibid., p. 28, pl. 1, fig. 9, 1902.

Remains of cattail leaves are not uncommon in the Mascall flora, and are present also at Stinking Water and Blue Mountains. This aquatic plant points to the presence of lake and marshy habitats in the region, as judged from the ecologic occurrence of such similar living species as Typha latifolia Linnaeus and T. angustifolia Linnaeus. The existence of such habitats in these areas is corroborated fully by the preservation of the plants in well bedded diatomaceous sediments of lacustrine origin.

The broad leaf blade identified by Lesquereux as Phragmites oeningensis is placed here in synonymy with Typha. Leaves of P. oeningensis, which have been recorded at many localities in the Tertiary of Holarctica, show relationship to those of P. communis Linnaeus, a widely distributed species in the Northern Hemisphere. Its leaves differ from those of Typha in having a slender midrib. Typha leaves also have a series of tertiary cross veins which are not present in Phragmites. Applying these criteria to the Lesquereux specimen leads to inconclusive results. There is a ridge on the specimen, but it is well removed from the center of the blade; it might be interpreted as representing a midrib of a partially folded leaf, but there is no evidence that the blade is folded or curled. No cross veins are present on the specimen. Concerning these same relationships, Roland W. Brown has recently remarked (letter, March 13, 1956): "There is no evidence of a strong midvein such as is usually seen in species of Arundinaria. No prominent cross veinlets like those commonly seen in Typha are present; but here one can be misled because leaves of Typha often do not show distinct cross veinlets until they have weathered for a time. Consequently, all large, grasslike leaves without midveins must be regarded with suspicion." Because its morphological features are somewhat obscure, and since Typha is well represented in this and other near-by floras, we are relegating this specimen to Typha; it might just as well be rejected from the flora, because it is not wholly diagnostic.

Since it is not always easy to assign fossil specimens to Typha or Pragmites (or other large grasses), it is possible that Phragmites was present in the Mascall and other floras in the Columbia Plateau region. The wide occurrence of grazing horses (Merychippus) in the Middle Tertiary rocks of the region clearly indicates that harsh grasses were present as a food source for these large mammals. Judging from the occurrence of grasses today in forests that show relationship to the Mascall flora, we may infer that grassy patches probably were scattered both as small openings in the forest and as larger areas of prairie on bordering slopes. In addition, the well drained, gravelly stream bottoms of the region no doubt supported grass communities much like those of today on broad river flats in the Mississippi Valley.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P28, P4129), homeotype no. 2914. Blue Mountains, Ore.: U. C. M. P. (loc. 3936). Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), homeotype no. 2915. Latah, Wash.: U. S. N. M. (Spokane loc.). Trout Creek, Ore.: U. C. M. P. (loc. P275), homeotype no. 641. Upper Cedarville, Cal.-Nev.: U. C. M. P. (locs. P97, P115), homeotype no. 831. Lower Idaho, Ida.: U. C. M. P. (all locs.), homeotype no. 1172. Succor Creek, Ore.: U. C. M. P.

## Family POTAMOGETONACEAE

### Potamogeton parva Brown

Potamogeton parva Brown, Jour. Wash. Acad. Sci., vol. 30, p. 348, text fig. 16, 1940.

The basal part of a small floating leaf of pondweed is represented in the Stinking Water flora. It is similar to the specimen figured by Brown from Gray's Ranch, but differs in having an acute rather than cuneate base. Because of the limited material in both floras, it does not seem advisable now to distinguish between these specimens. Both show relationship to such widely distributed species as *Potamogeton diversifolius* Rafinesque and *P. dimorphus* Rafinesque.

*Occurrence*. Stinking Water, Ore.: U. C. M. P. (loc. P4006), homeotype no. 4422.

### *Cyperacites* sp. Knowlton

(Plate 10, figure 3)

*Cyperacites* sp. Knowlton, U. S. Geol. Surv. Bull. 204, p. 28, pl. 1, fig. 9, 1902.

A fragment of a leaf, discovered at the White Hills Mascall locality at the very end of our field study, resembles the specimen considered to represent "a large cyperaceous plant" by Knowlton. It seems more probable that it is a grass of the *Panicum* type, though there is no value in attempting to make either a family or a generic determination. Gray has noted the presence of pollen which she refers to the Gramineae, and we have elsewhere considered the probability that there were grasslands adjacent to the Mascall forests.

Our figured specimen shows 7 veins of almost equal stoutness. In such modern grasses as *Panicum capillare* and *P. taxanum* there is a heavier midvein proximad, but no difference in vein-strength at the upper end of the leaf. This and other genera of widely distributed grasses contain numerous large-leafed species, many of which are of common occurrence on the borders of lakes and streams.

*Occurrence*. Mascall, Ore.: U. C. M. P. (loc. P3735), hypotype no. 2853.

## Family LILIACEAE

### *Smilax magna* Chaney

(Plate 16, figures 1, 2)

*Smilax magna* Chaney, Contr. Walker Mus., vol. 2, p. 161, pl. 6, fig. 1, 1920.

MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 49, 1933.

Brown, U. S. Geol. Surv. Prof. Paper 186, p. 168, pl. 46, fig. 15, 1937.

*Smilax lamarensis* Knowlton. Berry, U. S. Geol. Surv. Prof. Paper 154, p. 240, pl. 63, fig. 15, 1929.

Berry, U. S. Geol. Surv. Prof. Paper 185, p. 105, pl. 19, fig. 7, 1934.

Three leaves in the Mascall flora and another in the Blue Mountains are referred to this species. It is realized that it is not possible in most cases to distinguish species of Smilax on the basis of foliar characters. We are assigning our specimens to the Eagle Creek species, because we find in such modern vines as *Smilax rotundifolia* Linnaeus, *S. hispida* Muhlenberg, *S. bona-nox* Linnaeus, and *S. glauca* Walter leaves much like our fossils and like *S. magna* Chaney. Until more Tertiary material becomes available for study it seems desirable to group all these generally similar leaves together under the same species.

A thin, branching stem, 9 inches long, in the Stinking Water flora may represent Smilax. It closely resembles slender branches of the modern vines of this genus in the disposition of the nodes and the presence of small recurved spines on the stem. We provisionally refer this specimen to Smilax, but point out that leaves of Smilax have not yet been discovered in the flora.

Leaves of *S. diforma* Condit from the Neroly and Remington Hill floras (Condit, 1938, 1944a) are similar to *S. magna* Chaney, and further collections may show that they represent the same species.

*Occurrence*. Mascall, Ore.: U. C. M. P. (locs. P3735, P28, P4123), hypotype no. 2916, homeotypes nos. 2917, 2918. Blue Mountains, Ore.: U. C. M. P. (loc. P3937), hypotype no. 2919. Stinking Water, Ore.: U. C. M. P. (loc. P4120), homeotype no. 2920. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Whitebird locs.). Trout Creek, Ore.: U. C. M. P. (loc. P275), homeotype no. 559.

### *Smilax wardii* Lesquereux

*Smilax wardii* Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 19, pl. 13, fig. 1, 1888.

The specimen figured by Lesquereux is the only material representing this species in the Mascall flora. Since it appears to have the typical venation of Smilax, we are retaining it in this genus. We have not yet seen a living Smilax, however, that closely matches *Smilax wardii* in shape. The leaves of a number of modern species are slender and lanceolate like the fossil, and have a similar venation, yet all of them have acute to rounded bases, rather than deeply auriculate like *S. wardii*. Although auriculate leaves are commonly found in species of Smilax, they regularly have an oval to ovate shape. It thus seems probable that *S. wardii* represents an extinct member of the genus, a species characterized by narrowly lanceolate leaves with deeply auriculate bases, which has no surviving counterpart.

*Occurrence*. Mascall, Ore.: U. S. N. M.

## Family SALICACEAE

### Populus eotremuloides Knowlton

(Plate 17, figure 4)

Populus eotremuloides Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 725, pl. 100, figs. 1, 2; pl. 101, figs. 1, 2, 1898.
LaMotte, Carnegie Inst. Wash. Pub. 455, p. 114, pl. 5, figs. 7, 9, 1936.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 169, pl. 47, fig. 1, 1937.
Populus lindgreni Knowlton. Oliver, Carnegie Inst. Wash. Pub. 455, p. 17 (part), 1934.
MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 49 (part), 1933.

Only 3 specimens representing this species have been collected from the Blue Mountains flora. Populus was not common along lake and river banks near sites of deposition in eastern Oregon during the Miocene. It is also rare in the Latah flora to the northward, and is not common in the Trout Creek and Upper Cedarville floras to the southward. Interiorward, however, where the climate was somewhat cooler, it is found in greater abundance in the Payette and Thorn Creek floras. Populus did not become a common member of lowland riparian vegetation in eastern Oregon until the Pliocene, when smaller-leafed and thicker-textured types make their appearance in the record. Since these younger species are clearly derivative forms, we have correlated the trend from larger, thinner-textured leaves in the Miocene species to smaller and thicker leaves in the Pliocene types with a gradual reduction in rainfall and lowered temperatures, changes which were at least in part due to the climatic barrier imposed between eastern Oregon and the coast by the rising Cascades (Chaney, 1938b, pp. 212-213).

Populus eotremuloides Knowlton resembles several living species of cottonwood. In the western United States it finds a close equivalent in the ubiquitous P. trichocarpa Torrey and Gray, which ranges from British Columbia southward into Baja California and southeastward into the Rocky Mountains, where the form hastata Dode has been recognized. Black cottonwood is associated today with species representing descendants of all five components of the West American Element: the North-Coast Coniferous, Redwood, Border-Redwood, Sierra-Cascade, and Rocky Mountain. In Canada and the eastern United States P. balsamifera Linnaeus, which is not greatly different from P. trichocarpa, also shows resemblance to the fossil P. eotremuloides. Populus balsamifera is a common stream- and lake-border tree in the beech-maple forest of the northeastern United States, a forest that has many species with counterparts in the Blue Mountains flora. There are two species in eastern Asia that also resemble P. eotremuloides, but this relationship is not so close as that displayed by the P. trichocarpa – P. balsamifera phylad. Populus adenopoda Maximowicz of central and eastern China has leaves similar to P. eotremuloides. Populus suaveolens Fischer, ranging from Manchuria through central China southwestward into Turkestan, does not differ greatly from the fossil species. The survival today in eastern Asia, western North America, and eastern North America of cottonwoods showing relationship to a Miocene species is paralleled by that of species in such genera as Alnus and Betula. We conclude that they all had a common origin in the Arcto-Tertiary Geoflora to the northward early in the period. The minor variation seen today in these similar yet widely separated species has gradually developed during the later Cenozoic as derivatives of the Arcto-Tertiary Geoflora became adapted to different environmental conditions on the American and Asian continents.

The 3 specimens in the Blue Mountains flora assigned by Oliver to P. lindgreni actually represent two other species. Two of the specimens (nos. 662, 663) are P. eotremuloides Knowlton, and the third (no. 661) is an excellent example of P. washoensis Brown. Populus eotremuloides has been recorded at only a few Miocene localities, and except at Payette and Thorn Creek seems to have been nowhere abundant near sites of deposition during the Miocene.

Occurrence. Blue Mountains, Ore.: U. C. M. P. (loc. P3937), hypotype no. 662, homeotypes nos. 663, 2921. Trout Creek, Ore.: U. M. M. P. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotypes nos. 782, 784. Payette, Ida.: U. S. N. M.; U. C. M. P. (loc. P3743). Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600). Succor Creek, Ore.: U. S. N. M.; U. C. M. P. Lower Idaho, Ida.: U. C. M. P. (loc. P637).

### Populus lindgreni Knowlton

(Plate 17, figures 1-3)

Populus lindgreni Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 725, pl. 100, fig. 3, 1898.

Supplementary description. Leaves broadly ovate to nearly circular in outline; blade 7.5 to 8.4 cm. long and 7.0 to 9.8 cm. wide; tip obtuse to subacute; base truncate to cordate; petiole very stout, 3.5 to 5.5 cm. long; midrib stout, straight or somewhat displaced above by departing secondaries; strong primaries reaching up to middle of blade or just above, giving off 3 to 4 prominent subparallel secondaries that arch upward in broad loops, occasionally bifurcating within margin to supply marginal area and teeth; 4 to 5 heavy secondaries above basal primaries and subparallel to them, looping upward, giving off strong tertiaries on abaxial side that supply marginal area; a conspicuous basal pair of veins and occasionally another supplementary set below them in cordate leaves; tertiary mesh irregularly cross-percurrent to irregular, enclosing a fine mesh in which the finest veinlets end in relatively open polygons and terminate with prominent cross T's; margin with numerous crenate-serrate teeth; texture firm to heavy.

*Discussion*. *Populus lindgreni* is only sparsely represented in the floras of the Columbia Plateau region. Leaves from the Mascall and Stinking Water floras include specimens the size of the figured Payette type, as well as some that are fully twice as large as those shown on plate 17. All this material can be closely matched by leaves of the modern swamp poplar, *P. heterophylla* Linnaeus of the Mississippi Basin and Atlantic coastal region; the fossils so closely resemble this species that they can scarcely be separated (see U. C. Herbarium sheets 4950, 743970). *Populus heterophylla* is found about the borders of ponds and swamps together with swamp cypress, tupelo, red maple, hackberry, sycamore, sweet gum, and many other plants having close counterparts in the Mascall, Payette, and Stinking Water floras.

*Populus lindgreni* has hitherto been considered most nearly related to aspen, *P. tremuloides* Michaux. Detailed comparisons show that *P. lindgreni* differs from the leaves of *P. tremuloides* in several respects: *P. lindgreni* regularly has a prominent pair of large basal veins below the primaries, as contrasted with the thinner pair (or none) in aspen; the petiole of *P. lindgreni* is thick and stout as compared with the slender petiole of *P. tremuloides*; the midrib and secondaries of *P. lindgreni* are generally thicker; the leaves of *P. lindgreni* tend to be broadly ovate and sometimes cordate as contrasted with the typical ovate to rounded leaves of *P. tremuloides*; leaves of *P. lindgreni* have blunt to subacute tips as compared with the submucronate tips of aspen; *P. lindgreni* has relatively coarser teeth; *P. lindgreni* leaves appear to have had a thicker and heavier texture than those of aspen.

*Occurrence*. Payette, Ida.: U. S. N. M.; U. C. M. P. (loc. P3734). Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P28), hypotypes nos. 2923, 2923a. Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotypes nos. 2924, 2925, homeotypes nos. 2926, 2930. Latah, Wash.: U. S. N. M. (Spokane loc.). Succor Creek, Ore.: U. C. M. P. (loc. P3746).

### *Populus voyana* new species

(Plate 18, figures 1, 3, 4)

*Populus lindgreni* Knowlton, U. S. Geol. Surv. Bull. 204, p. 29, pl. 2, fig. 1, 1902.
MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 49 (part), 1933.
Brown, Jour. Wash. Acad. Sci., vol. 36, p. 345, fig. 12, 1946.

*Description*. Leaves broadly ovate to rounded and orbicular; blade 5.5 to 7.0 cm. long and 4.5 to 6.0 wide; tip subacuminate; base rounded to obtuse; a typically long, slender petiole, up to 3.2 cm. preserved and probably longer; midrib slender, straight to slightly curving, partially displaced in upper part of blade by departing secondaries; basal primaries arching upward into upper half of blade, giving off prominent subparallel secondaries which loop evenly upward, occasionally bifurcating near the margin; 3 to 4 secondaries diverging from midrib above basal primaries, and regularly subparallel to them as they loop upward; a thin pair of basal veins submarginal in position in proximal part of blade; tertiaries irregularly cross-percurrent, enclosing a coarse irregular meshwork; margin with numerous small, crenate-serrate teeth; texture medium.

*Discussion*. *Populus voyana* is characterized by (1) large orbicular leaves, (2) small, closely spaced teeth, (3) basal secondaries reaching well upward into the upper half of the blade, and (4) a long, slender petiole. Close relationship is apparent between *P. voyana* and leaves of the living aspen, *P. tremuloides* Michaux, a widely distributed tree in North America. The fossil compares most nearly with aspen in the more mesic parts of its range, where its leaves are regularly larger than those formed in the drier parts of its distribution.

*Populus lindgreni* Knowlton has for many years been considered closely allied to *P. tremuloides*. As discussed above, our current studies of *P. lindgreni*, based on additional material from the Payette, Stinking Water, and Mascall floras, indicate that it is more nearly related to *P. heterophylla*, the swamp poplar of the eastern United States. This alliance is suggested by the thicker petiole, the thicker veins, the stronger basal pair of secondaries, the somewhat more ovate shape, and the coarser teeth. The leaves of *P. voyana* differ from those of *P. pliotremuloides* Axelrod in their larger size and thinner texture.

The species is named in honor of Charles D. Voy, who in the early seventies obtained specimens of Mascall plants either by exchange or by actual collecting.

*Occurrence*. Mascall, Ore.: U. S. N. M. (holotype); U. C. M. P. (locs. P28, P4129), hypotype no. 2922. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), hypotypes nos. 561, 562. Latah, Wash.: U. S. N. M. (Spokane loc.-Vera). Latah, Ida.: U. S. N. M. (Coeur d'Alene loc; E. of Orofino).

### *Populus washoensis* Brown

(Plate 18, figures 5-8)

*Populus washoensis* Brown, Jour. Wash. Acad. Sci., vol. 27, p. 516, 1937.
Smith, Amer. Mid. Naturalist, vol. 25, p. 496, pl. 3, figs. 1, 2, 6, 1941.
*Populus lindgreni* Knowlton. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 115, pl. 4, fig. 1, 1936.

Oliver, Carnegie Inst. Wash. Pub. 455, p. 17 (part), 1934.
Populus booneana Smith, Amer. Mid. Naturalist, vol. 25, p. 494, pl. 2, figs. 14, 15, 1941.

One of the 3 specimens (no. 661) assigned by Oliver to Populus lindgreni has the large, widely spaced teeth typical of P. washoensis; the other 2 specimens represent P. eotremuloides as discussed above. Our more recent collections from the Blue Mountains localities have yielded 6 additional specimens of P. washoensis.

Brown (1937b, p. 516) has noted that the leaves of P. washoensis resemble those of the living large-toothed aspen, P. grandidentata Michaux. This is a common tree in the beech-maple forest of the northeastern United States, a forest having many species closely related to those composing the beech-maple community of the Blue Mountains flora. Another living poplar showing equally close or even closer affinity to P. washoensis is P. tremula Linnaeus and its variety davidiana Schneider, a widely distributed tree in eastern Asia, ranging from Siberia and Manchuria to Yunnan. It is a member of the hardwood-deciduous and conifer forests that are related historically to similar vegetation in eastern North America.

Populus washoensis Brown is known at present from only four Miocene floras in the western United States, as cited below. Pliocene floras from which it has been collected are the Alvord Creek of Oregon, the Verdi of western Nevada (Axelrod, MS), the Black Hawk Ranch and Mulholland of the San Francisco Bay area (Axelrod, 1944a, 1944b), and the Etchegoin of the Coalinga region in the south Coast Ranges (U. C. Mus. Paleontol.). Some of these Pliocene leaves, especially specimens from the Mulholland and Verdi floras, have a smaller average size than the Miocene P. washoensis Brown. They represent a new Pliocene species, P. subwashoensis Axelrod (Axelrod, 1956, p. 284), differing from the Miocene large-toothed aspen in the same way that P. alexanderi Dorf differs from the Miocene P. eotremuloides Knowlton, namely in having a smaller size and thicker texture. This trend toward the development of smaller, thicker-textured leaves in such genera as Acer, Amelanchier, Populus, Quercus, Rosa, and Ulmus has been correlated with a change from a climate with ample rainfall and mild temperature in the Miocene to one of diminished rainfall, greater sunshine, and increased ranges and extremes of temperature in the Late Cenozoic.

The specimens of P. booneana Smith cited above were compared by Smith with leaves of P. tremuloides Michaux and P. rotundifolia Griffith of southern Asia. Populus booneana represents no more than the small leaves of P. washoensis; specimens of the modern P. tremula var. davidiana regularly bear large and small leaves on the same twig that match the fossils Smith identified as P. washoensis and P. booneana, as do leaves on occasional twigs of P. grandidentata.

Occurrence. Blue Mountains, Ore.: U. C. M. P. (locs. P3936, P3937), hypotypes nos. 2927, 2928, 2929, homeotype no. 661. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), lectotype no. 956. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600). Trout Creek, Ore.: U. M. M. P. Succor Creek, Ore.: U. M. M. P.

### Salix boisiensis Smith

(Plate 16, figures 9, 10)

Salix boisiensis Smith, Amer. Mid. Naturalist, vol. 25, p. 498, pl. 2, fig. 3; pl. 4, fig. 8, 1941.
Axelrod, Carnegie Inst. Wash. Pub. 553, p. 194, pl. 36, figs. 8-10, 1944.
Salix spokanensis (Berry) Brown. Smith, Amer. Mid. Naturalist, vol. 25, p. 498, pl. 4, figs. 9, 10, 1941.

Five leaf impressions in the Mascall flora, all having an obovate shape and a tapering base, represent this species, which seems closely allied to the living Salix scouleriana Barratt. This small tree is distributed widely in western North America, ranging from the Yukon southward through British Columbia to northern California and eastward through Washington and Oregon to northern Idaho and Montana. It lives along river valleys in the North-Coast Coniferous, Redwood, Sierra-Cascade, and Rocky Mountain forests, which have numerous species related to fossil plants in the Mascall and similar floras.

Aside from its Mascall and Thorn Creek occurrences, S. boisiensis is known from the Upper Pliocene Sonoma flora north of San Francisco Bay (Axelrod, 1944d) and from the Middle Pliocene Verdi ("Truckee") flora near Reno, Nevada (Axelrod, MS). The Thorn Creek specimens of S. spokanensis (Berry) Brown cannot be separated from leaves of S. boisiensis and are easily matched by those of the living equivalent; we therefore place it in synonymy under S. boisiensis. Salix libbeyi Lesquereux from Florissant (Lesquereux, 1883; MacGinitie, 1953) has leaves somewhat like S. boisiensis, and the two species may be related; S. libbeyi differs in having greater dimensions and an acute rather than rounded tip.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P4129, P28), hypotypes nos. 2931, 2932, homeotype no. 2933. Thorn Creek, Ida.: U. C. M. P. (loc. P4600); U. M. M. P.

### Salix hesperia (Knowlton) Condit

(Plate 19, figure 7)

Salix hesperia (Knowlton) Condit, Carnegie Inst. Wash. Pub. 553, p. 41, fig. 6, 1944 (see synonymy).
Arbutus matthesii Chaney. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 140, pl. 14, fig. 1 only, 1936.

Juglans hesperia Knowlton. Dorf, Carnegie Inst. Wash. Pub. 476, p. 110 (part), 1936.
Populus lesquereuxi Cockerell. Berry, U. S. Geol. Surv. Prof. Paper 170, p. 35, 1931.
Berry, U. S. Geol. Surv. Prof. Paper 185, p. 106, 1934.

Leaves of this characteristic Miocene species of the western United States are not common in our collections; a total of 7 specimens has been recorded in the Mascall and Stinking Water floras.

Salix hesperia has been compared by several authors with the living S. lasiandra Bentham of the western United States. Close comparison may be made also with leaves of S. cordata Muhlenberg, a common species of the eastern United States and adjacent Canada. Leaves of this willow seem to resemble the fossil S. hesperia more nearly, because the secondaries regularly diverge from the midrib at high angles and curve evenly upward to the margin. Salix lasiandra has leaves of this type, as well as those with straighter secondaries that depart from the midrib at about 40°, a feature rarely seen in S. hesperia.

The type specimen of Salix schimperi Lesquereux from Cherry Creek (Lesquereux, 1888, pl. 13, fig. 5) has been examined, and we note a close similarity to S. hesperia. When additional material of S. schimperi becomes available, it may be shown to be conspecific with S. hesperi.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P28, P4129), homeotypes nos. 2935, 2936, 2937. Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotype no. 2934. Upper Cedarville, Cal.: U. C. M. P. (loc. P115), homeotype no. 825. Lower Idaho, Ida.: U. C. M. P. (loc. P638), homeotype no. 1175. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird locs.). Payette, Ida.: U. S. N. M. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600).

### Salix owyheeana new name

(Plate 18, figure 2)

Magnolia oregonensis Chaney. Smith, Amer. Mid. Naturalist, vol. 25, p. 512, pl. 14, fig. 5, 1941.

The specimen figured by Smith is an entire-margined (the apparent teeth in her illustration are due to breakage along the margin), oblong leaf representing a new species of willow. We are refiguring this specimen, which is described as follows.

Description. Leaf oblong, 6 cm. long and 3 cm. wide near middle of blade; petiole missing, apparently thick; 10 alternate secondaries diverging at moderate angles, looping evenly upward to join the pair above well within the margin by tertiary crossties; intersecondaries few; subirregular tertiaries trending generally at right angles to secondaries especially near the margin; finer mesh irregular; texture firm.

Discussion. This leaf is closely similar to those produced by the modern Salix hookeriana Barratt of the coastal region from northern California to British Columbia. The only other fossil material similar to it is in the Middle Pliocene Petaluma flora north of San Francisco Bay.

Occurrence. Thorn Creek, Ida.: U. M. M. P.

### Salix succorensis new species

(Plate 16, figure 8)

Salix inquirenda Knowlton. Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 111, pl. 6, fig. 3, 1939.

The Succor Creek specimen figured by Smith differs from leaves of Salix hesperia (Knowlton) Condit (=S. inquirenda Knowlton) in being more slender.

Description. Leaf narrowly lanceolate, acuminate above, narrowed below to a cuneate base; 16.5 cm. long and 1.5 cm. wide; petiole thick, 3 mm. preserved; midrib thick below, gradually tapered and curving above; numerous thin, alternate secondaries diverging from midrib about 50° to 60°, then curving upward in broad loops to join secondaries above near margin; intersecondaries diverging at moderate angles; tertiaries irregularly percurrent; finer mesh irregular; texture firm.

Discussion. Salix succorensis is now known from two floras, the Succor Creek and Stinking Water, and is represented by a single specimen in each flora. This species is much like S. nigra Marshall and also shows relationship to some of the sandbar willows, notably S. longipes Andersson. A somewhat similar species has been recorded as S. longiacuminata Knowlton from the Oligocene Weaverville flora of northwestern California (MacGinitie, 1937, pl. 5, figs. 1, 2) and the Eocene Green River flora of Colorado (Brown, 1934, pl. 8, figs. 7, 8), but it differs in having narrower, longer leaves. Another related species is S. truckeana Chaney from the Pliocene Dalles and Verdi floras (Chaney, 1944b, pl. 52, figs. 2-6), which has smaller leaves.

Occurrence. Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotype no. 4423. Succor Creek, Ore.: U. M. M. P.

### Salix venosiuscula Smith

Salix venosiuscula Smith, Amer. Mid. Naturalist, vol. 25, p. 500, pl. 3, fig. 7; pl. 4, fig. 6, 1941.
Salix coalingensis Dorf, Carnegie Inst. Wash. Pub. 476, p. 110, 1936.
Salix florissanti Knowlton and Cockerell. Chaney, Carnegie Inst. Wash. Pub. 476, p. 215, pl. 6, fig. 3, 1938.

*Salix vanorensis* Axelrod, Carnegie Inst. Wash. Pub. 553, p. 282, pl. 48, figs. 1, 2, 1944.

Axelrod has suggested that the Thorn Creek *Salix venosiuscula* Smith might represent no more than variation of the larger-leafed *S. hesperia* (Knowlton) Condit, which is represented in that flora by *S. schimperi* Lesquereux (Axelrod, 1944g, p. 282). Examination of the large suite of willow material in the Thorn Creek collection shows that this view is not tenable, for both species are represented in that flora.

The narrow-leafed willow described as *S. vanorensis* Axelrod from the Alturas, Deschutes, and Lower Idaho floras is indistinguishable from the Thorn Creek *S. venosiuscula* Smith, and is therefore placed in synonymy under it.

The fossil leaves of *S. venosiuscula* are similar to those of the living *S. caudata* (Nuttall) Heller, which extends from northeastern California northward to Canada on the lee side of the Cascades, and eastward to the Rocky Mountains. *Salix caudata* is related to *S. lasiandra*, but differs from it principally in having smaller and thicker-textured leaves. It seems probable that *S. venosiuscula* may have differentiated gradually from the related Miocene species *S. hesperia* (and *S. schimperi*) at the interior during the late Miocene as the region became progressively drier and colder. If so, the humid species (*S. hesperia*) was gradually restricted coastward to areas of more moderate climate and survived on the coastward slopes as the closely related *S. lasiandra*. Its small-leafed differentiate, *S. venosiuscula*, persisted over the interior in the late Miocene and Pliocene, and has survived down to the present as the closely similar *S. caudata*.

*Occurrence*. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600). Lower Idaho, Ida.: U. C. M. P. (locs. P635, P636, P637, P638), hypotype no. 1174.

## Family LEITNERIACEAE

### *Leitneria pacifica* new species

(Plate 19, figure 6)

*Description*. Leaf lanceolate, tip missing but apparently acute to acuminate, base broadly cuneate; complete leaf blade estimated at 15.5 cm., widest near middle where it averages 4.3 cm.; petiole thick, only 1.2 cm. preserved; midrib thick and firm, gradually tapering above; 12 to 13 alternate secondaries and occasional intersecondaries, secondaries in lowest part of blade diverging at about 60° to 65°, those above at 35° to 40°, looping upward gradually, camptodrome along margin, often giving off strong tertiaries in outer part to supply marginal area; tertiary pattern between secondaries irregular, joining secondaries by acute angles; finer mesh polygonal; margin entire and apparently slightly revolute; texture thick.

*Discussion*. This is the first record of the genus Leitneria in the Tertiary. The fossil resembles *Leitneria floridana* Chapman, the single species of its genus, which is now confined to the swamps of the southern states. It is nowhere common, and is known from only a few areas, including the swamplands bordering the St. Francis River of Missouri and Arkansas, the edges of swamps along the lower Altamaha River, Georgia, the saline marshes near Apalachicola, Florida, and along the Brazos River valley in coastal Texas near Columbia. It is found typically with the swamp cypress forest, an association that has many equivalent species in the Mascall flora.

*Occurrence*. Mascall, Ore.: U. C. M. P. (loc. P3735), holotype no. 2938.

## Family JUGLANDACEAE

### *Carya bendirei* (Lesquereux) new combination

(Plate 19, figures 1-5)

*Rhus bendirei* Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 15, pl. 9, fig. 2, 1888.

*Salix engelhardti* Lesquereux, ibid., p. 17, pl. 8, fig. 2, 1888.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 29, 1902.

*Magnolia lanceolata* Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 13, 1888.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 58, 1902.

*Cassia phaseolites* ? Unger. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 16, 1888.

*Salix amygdalaefolia* Lesquereux, ibid., p. 17, 1888.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 30, 1902.

*Salix varians* Goeppert. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 17, 1888.

*Salix mixta* Knowlton, U. S. Geol. Surv. Bull. 204, p. 32, pl. 2, fig. 12 (leaflet on left only), 1902.

*Prunus ? merriami* Knowlton, ibid., p. 67, pl. 11, figs. 2, 6, 7 (not fig. 3, which is *Pterocarya mixta* [Knowlton] Brown), 1902.

*Prunus ? tufacea* Knowlton, ibid., p. 68, pl. 11, fig. 4, 1902.

*Celastrus confluens* Knowlton, ibid., p. 71, pl. 12, figs. 1-3, 1902.

*Aesculus simulata* Knowlton, ibid., p. 78, pl. 15, figs. 1, 2, 1902.

*Rhus* ? sp. Lesquereux. Knowlton, ibid., p. 70, pl. 14, fig. 6, 1902.

*Carya egregia* (Lesquereux) LaMotte, Carnegie Inst. Wash. Pub. 455, p. 116, pl. 4, figs. 5, 6; pl. 6, figs. 1, 2, 1936.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 169, pl. 57, fig. 4, 1937.
Smith, Amer. Mid. Naturalist, vol. 25, p. 500, pl. 5, fig. 3, 1941.

*Carya simulata* (Knowlton) Brown, U. S. Geol. Surv. Prof.

Paper 186, p. 169, 1937.
Hicoria pseudovata Hollick, Mem. New York Bot. Garden, vol. 7, p. 395, pl. 30, figs. 1, 2, 1927.
Juglans egregia Lesquereux. Berry, U. S. Geol. Surv. Prof. Paper 170, p. 35, pl. 11, fig. 3, 1931.
Ptelea miocenica Berry. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 133, pl. 11, fig. 4 only, 1936.
Quercus distincta Lesquereux. LaMotte, ibid., p. 123, pl. 7, fig. 3 only, 1936.
Arbutus matthesii Chaney. LaMotte, ibid., p. 140, pl. 14, fig. 3 only, 1936.

A new name for the hickory previously known as Carya egregia (Lesquereux) LaMotte is needed because the specific name egregia was derived from the Middle Eocene Chalk Bluffs specimens of Juglans egregia Lesquereux, which MacGinitie has shown are Gordonia (MacGinitie, 1941, p. 149). The first described species from the western Miocene that is undoubtedly this Carya is Rhus bendirei Lesquereux from the Mascall, and it forms the basis for the new combination, Carya bendirei (Lesquereux) Chaney and Axelrod. All changes of name that are affected by this new combination are indicated in the synonymy above.

We are inclined to disagree with certain of the items placed in synonymy under Carya egregia (Lesquereux) LaMotte by LaMotte (1936) and by Brown (1937a). The specimen of Juglans oregoniana Lesquereux (Lesquereux, 1878a, pl. 9, fig. 10) was considered a Carya by LaMotte (1936) and Brown (1937a). We interpret it as Pterocarya. The Bridge Creek specimens of Juglans cryptata Knowlton (Knowlton, 1902, pl. 6, figs. 4, 5) have been synonymized with Carya egregia by Brown (1937a), but we believe that they represent another species, differing in having oblong leaflets that are regularly rounded, not tapered below as in the Miocene species. This material, which is closely similar to leaflets of the modern Carya cordiformis C. Koch, we rename Carya cryptata (Knowlton) Chaney and Axelrod. This species is related to C. typhinoides (Lesquereux) Condit of the Table Mountain flora, but differs from it in having consistently larger leaflets.

Two of the specimens cited in synonymy above, Aesculus simulata Knowlton and Rhus ? sp. Knowlton, have been considered by Brown (1937a, p. 169) to represent a distinct species, Carya simulata (Knowlton) Brown. The principal basis for differentiation seems to lie in the fact that these leaflets have more closely spaced secondaries. When our large Mascall collection of Carya leaflets is reviewed, all specimens seem to fall readily within the range of variation of one botanic species. We note also that the pignut hickory, C. glabra Sweet, with which Brown has compared these specimens, regularly has leaflets that are more slender than the fossils.

The fossil species C. bendirei shows close relationship to the living C. ovata (Miller) K. Koch, the common shagbark hickory of the eastern United States. This large tree thrives best on low hills and along the banks of streams, where it is associated with numerous species having close relatives in the Mascall and related floras.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P4123, P28, P4129), hypotypes nos. 2939-2942 incl., homeotypes nos. O.S. 885, O.S. 887, 2945, 2946. Payette, Ida.: U. C. M. P. (loc. P3743), hypotype no. 2943. Upper Cedarville, Nev.-Cal.: U. C. M. P. (locs. P97, P115), hypotypes nos. 787, 789, 785, 792, 810, 827. Latah, Wash.-Ida.: U. S. N. M. (Grand Coulee, Whitebird locs.). Thorn Creek, Ida.: U. M. M. P.

### Juglans browniana new species

(Plate 20)

Juglans oregoniana Lesquereux. Oliver, Carnegie Inst. Wash. Pub. 455, p. 18, 1934.
MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 50, 1933.
Salix mixta Knowlton. Oliver, Carnegie Inst. Wash. Pub. 455, p. 17, 1934.

The above-listed fossil leaflets from the Blue Mountains and Trout Creek floras are all alike and sufficiently distinct from previously recorded Juglans material to warrant their inclusion in the following description of a new walnut, which is based on the excellent specimen shown on plate 20.

Description. Complete leaf estimated at about 23 cm. long; petiole 4.5 cm. long; 12 opposite leaflets preserved, lanceolate, rounded to subcordate at base, widest in the lower third, tapering gradually above to a long acuminate apex; leaflets in lower part 5.8 cm. long, those just above the middle 11.0 cm.; 11 to 18 alternate secondaries, somewhat irregular and wavering in their outward course, but generally straight or slightly concave, mostly diverging at 60° to 70° except in the upper part where the angle may increase to nearly 90°, looping upward well within the margin and gradually becoming thinner and finally meeting the secondary above where it commences to loop, thus forming an acute angle at the point of juncture; tertiaries irregular; finer pattern not preserved; margin sharply serrate, supplied by irregular tertiaries from the looping secondaries; texture firm.

Discussion. Juglans browniana is similar to the leaves and leaflets of the modern J. nigra Linnaeus of the eastern United States. Before the extensive logging for its valuable timber, black walnut was a common and widely distributed tree, ranging from Massachusetts and New York to Georgia, westward across the Mississippi Basin to eastern Texas, and thence northward through eastern Louisiana, Oklahoma, and Nebraska into Michigan and Wisconsin.

The specimens identified by Oliver as Juglans oregoniana and Salix mixta represent no more than the normal variation displayed by the modern species which most closely resembles J. browniana. The specimen identified by Brown as Carya egregia also reveals the diagnostic features of Juglans in its rounded base and looping secondaries which do not fork prominently near the margin. MacGinitie identified a fine leaflet in the Trout Creek as J. oregoniana, and compared it with the modern black walnut; this specimen is herewith transferred to the new species, J. browniana, for as indicated below J. oregoniana is now considered to represent Pterocarya. Another record of J. oregoniana is in the Neroly flora of west-central California (Condit, 1938); recent examination of these specimens has shown that they represent Salix hesperia (Knowlton) Condit rather than a walnut of the nigra type (Condit, 1944a, p. 41).

Authentic records of Juglans are not common in the Middle and Later Tertiary floras of the western United States. Juglans nevadensis Berry from the Truckee formation of Nevada (Berry, 1928) and from the Mount Eden flora of southern California (Axelrod, 1937), as based on numerous fruits and a leaflet, resembles the living J. californica Watson of southern California. Another species based on fruiting material is J. pseudomorpha Condit from the Remington Hill flora of transitional Mio-Pliocene age (Condit, 1944a), which shows relationship to both J. nigra and J. californica. Other than the Blue Mountains and Trout Creek records of J. browniana, we are not aware of any undoubted walnut material in the Miocene of the Columbia Plateau.

It is a pleasure to name this species in honor of Dr. Roland W. Brown, of the U. S. Geological Survey, who has contributed greatly to a better understanding of Miocene floras of the Columbia Plateau province.

Occurrence. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), holotype no. 2947, homeotypes nos. 659, 660. Trout Creek, Ore.: U. C. M. P. (loc. P275), homeotype no. 563.

### Pterocarya mixta (Knowlton) Brown

(Plate 21, figures 1, 2)

Pterocarya mixta (Knowlton) Brown, U. S. Geol. Surv. Prof. Paper 186, p. 170, pl. 47, figs. 2, 3, 1937.
Salix mixta Knowlton, U. S. Geol. Surv. Bull. 204, p. 32, pl. 2, fig. 11, fig. 12 (leaflet on right only), 1902.
Salix perplexa Knowlton, ibid., p. 31, pl. 2, fig. 7 only, 1902.
Prunus ? merriami Knowlton, ibid., p. 67, pl. 11, fig. 3 only, 1902.
Juglans oregoniana Lesquereux, Mem. Harvard Mus. Comp. Zoöl., vol. 6, no. 2, p. 35, pl. 9, fig. 10, 1878.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 36, 1902.
Juglans hesperia Knowlton. Dorf, Carnegie Inst. Wash. Pub. 476, p. 110 (part), 1936.
Carya egregia (Lesquereux) LaMotte. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 169, pl. 47, fig. 4, 1936.
Smith, Papers Mich. Acad. Arts, Sci. and Letters, vol. 24, p. 111, pl. 7, fig. 1, 1939.

Pterocarya leaflets are common in collections from the Mascall localities, but in both the Stinking Water and Blue Mountains floras only a single incomplete specimen has been found. The Salix mixta leaflets recorded from the Blue Mountains flora by Oliver (1934, p. 17) represent Juglans, not Pterocarya, as suggested by Brown (1937a).

Pterocarya specimens from the Mascall flora range in size from the small leaflets recorded by Knowlton as Salix mixta and Prunus ? merriami to the large specimen figured by Lesquereux as Juglans oregoniana. We can find no morphological basis for separating the large and small leaflets, because they are connected by specimens of intermediate size. They show a range of variation in shape and size similar to that exhibited by a number of living Asiatic species, notably Pterocarya stenoptera DeCandolle and P. caucasica C. A. Mey.

The Succor Creek specimen of Carya egregia (Lesquereux) LaMotte figured by Smith (1939b) does not display the characteristic bifurcation of the secondaries along the margin found in leaflets of hickory. This specimen can easily be matched by leaflets of Pterocarya, which commonly have looping secondaries that give off tertiaries to the marginal teeth. The leaflet figured by Brown (1936) as Carya egregia also appears to represent Pterocarya.

The specific name mixta must be retained for the Miocene species even though Juglans oregoniana Lesquereux was described earlier; the latter would become a later homonym of Pterocarya oregoniana Chaney (1944c). Pterocarya oregoniana Chaney from the Lower Pliocene Dalles and Troutdale floras of Oregon and the Upper Pliocene Napa flora of California (Axelrod, 1950) appears to differ from the Miocene P. mixta in having acute rather than blunt tips. It seems best to retain them as separate species until more material is at hand to show conclusively that they are the same.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (all localities), lectotype no. O.S. 1798, hypotypes nos. 2948, 2949, homeotypes nos. O.S. 886, O.S. 891, 2950, 2951. Blue Mountains, Ore.: U. S. N. M. Stinking Water, Ore.: U. C. M. P. (loc. P4120), homeotype no. 2952. Payette, Ida.: U. S. N. M. Lower Idaho, Ida.: U. C. M. P. (loc. P638), homeotype no. 1176. Succor Creek, Ore.: U. M. M. P. Latah, Wash.: U. S. N. M. (Spokane loc.).

## Family BETULACEAE

### Alnus fossilis Newberry

Alnus serrulata fossilis Newberry, U. S. Geol. Surv. Monog. 35, p. 66, pl. 46, fig. 6, 1898.
Alnus carpinoides Lesquereux. Smith, Amer. Mid. Naturalist, vol. 25, p. 502, pl. 6, fig. 5, 1941.

No useful purpose is served by the trinomial Alnus serrulata fossilis, so we are shortening it to A. fossilis Newberry. It should be pointed out that the type has been incorrectly illustrated in so far as the margin is concerned: most of the teeth are multiserrate rather than single or biserrate as shown in the drawing. Alnus fossilis finds a close counterpart in the living A. sinuata (Regel) Rydberg — A. alnobetula (Ehrhart) K. Koch phylad of middle to high latitudes of the Northern Hemisphere. Both trees are regular members of forest vegetation derived from the Arcto-Tertiary Geoflora.

Alnus fossilis is characterized by a multiserrate margin. The somewhat similar leaves of Betula thor Knowlton may be distinguished by their larger and fewer teeth. The leaves of B. fairii Knowlton and B. vera Brown are more likely to be confused with those of A. fossilis. The following features distinguish these species: (a) the leaves of Alnus are characterized by strong subsecondaries which diverge from the abaxial side of the secondaries in the outer part of the blade, whereas if subsecondaries are present in Betula they are only weakly developed; (b) in leaves of comparable size, Betula has more numerous and more closely spaced secondaries than Alnus; (c) in shape Alnus is generally wider in the lower half of the blade, not near the middle of the blade like Betula; (d) the marginal outline is more even in Betula than in Alnus.

The Thorn Creek specimen of Alnus carpinoides Lesquereux listed above has the numerous glandular teeth characteristic of A. fossilis. Smith (1941, p. 502) has pointed out that it is much like the leaves of A. sinuata (Regel) Rydberg, which we also consider a close living representative of A. fossilis. It should be noted that the Thorn Creek illustration has been reduced; the blade actually measures 5.5 cm. in length.

Related fossils in Early Tertiary floras of high northern latitudes have been figured by Heer from Grinnell Land as Betula brongniartii Heer (1878, vol. 5, pl. 6, fig. 1) and Corylus insignis Heer (ibid., pl. 5, fig. 7); from Iceland as Alnus kefersteinii (Goeppert) Unger (1868, vol. 1, pl. 25, fig. 9b); and from Cape Lyell (1876, vol. 4, pl. 15, figs. 1, 2) and Scott Glacier (ibid., pl. 29, fig. 2) in Spitzbergen as Corylus macquarrii (Forbes) Heer.

Occurrence. Bridge Creek, Ore.: U. C. M. P. Thorn Creek, Ida.: U. M. M. P.

### Alnus harneyana new species

(Plate 21, figures 3-9)

Crataegus gracilens MacGinitie. Oliver, Carnegie Inst. Wash. Pub. 455, p. 23, 1934.
Corylus macquarrii (Forbes) Heer. Oliver, ibid., p. 18, pl. 3, figs. 2, 4, 1934.

Description. Leaves ovate, with subacute to rounded apices and truncate to subcordate bases; largest leaves 12 cm. long including 3 cm. petiole and 6 cm. wide, smallest leaves 3.5 cm. long including 0.5 cm. petiole and 2.0 cm. wide, average specimens 4 to 6 cm. long and 3.5 to 4.0 cm. broad; midrib firm and straight except occasionally in upper part of blade where it may be somewhat irregular; secondaries varying from 11 in number in largest leaves to 5 and 6 in the smallest, 6 to 8 in those of average size, lowest pair departing from midrib well within the margin, diverging at 80° to 90° in most leaves, but looping downward in subcordate leaves to increase angle to 100°, and in leaves with subtruncate bases departing at 65° to 70°, those in middle of blade averaging about 50°, secondaries may be slightly recurved; tertiaries trending at right angles to secondaries, somewhat irregular and often bifurcating midway between secondaries; finer mesh irregular; margin sinuate with the lobes mostly rounded but varying to subacute, the marginal lobes with forward-pointing serrate teeth varying from 2 to 4 (averaging 3) on lower side of lobe and usually only 1 distally; texture subcoriaceous.

Discussion. This alder has leaves strikingly like those of the modern Alnus tenuifolia Nuttall of the western United States and A. hirsuta Turezaninow of northeastern Asia. In the western United States A. tenuifolia is associated with three modern forests, the Sierra-Cascade, Rocky Mountain, and North-Coast Coniferous, which have been derived from the Arcto-Tertiary Geoflora. Many other species in these forests also have equivalents in the Mascall flora. Among these are Abies concolor, A. magnifica, Acer glabrum. A. macrophyllum, Alnus rhombifolia, Amelanchier alnifolia, Betula occidentalis, Picea breweriana, and Thuja plicata.

The only fossil alder described from the western United States that resembles this species is Alnus macrodonta Knowlton from the Bridge Creek, and its various synonyms such as Betula heterodonta, B. heteromorpha, Populus polymorpha, and Quercus pseudo-alnus. The Bridge Creek species may well represent a member of the A. tenuifolia group that became extinct in the late Oligocene. Such an interpretation is suggested by the fact that A. macrodonta has not been recorded in younger floras, and by the fact that alders more nearly resembling the tenuifolia type have been recorded in older floras to the northward. From the early Tertiary of Alaska Hollick figures a leaf of Alnus corylina (1936, pl. 50, fig. 1) that is hardly distinguishable from some of our specimens. Since it more nearly resembles A. harneyana than any specimens of A. macrodonta, we suggest that the latter species was not on the line of A. tenuifolia evolution and probably did not give rise directly to the modern species.

Alnus harneyana is one of the commoner species at Stinking Water, and is represented by several specimens from the Blue Mountains, but is absent from the Mascall flora. In our opinion the fragmentary leaves

*Acer florissanti* Kirchner.
Berry, 1934, pl. 24, figs. 5-7
= *Acer glabroides* Brown ......... 193

*Acer gigas* Knowlton.
Knowlton, 1902, pl. 14, fig. 1
= *Acer bendirei* Lesquereux ..... 191

*Acer heterodentatum* (Chaney) MacGinitie.
MacGinitie, 1953, pl. 57, fig. 3
= *Acer minor* Knowlton ............ 194

*Acer medianum* Knowlton.
Knowlton, 1902, pl. 14, figs. 4, 5
= *Acer bolanderi* Lesquereux .... 192

*Acer merriami* Knowlton.
Berry, 1929, p. 256
= *Acer bendirei* Lesquereux ..... 191
This specimen is from Coeur d'Alene, Idaho, not Vera, Washington.

*Acer merriami* Knowlton.
Berry, 1931, pl. 13, fig. 13
= *Acer oregonianum* Knowlton ... 195

*Acer merriami* Knowlton.
MacGinitie, 1933, pl. 10, fig. 1
= *Acer oregonianum* Knowlton ... 195

*Acer merriami* Knowlton.
LaMotte, 1936, pl. 12, fig. 7
= *Acer oregonianum* Knowlton ... 195

*Acer merriami* Knowlton.
Dorf, 1936, pl. 3, fig. 8
= *Acer bolanderi Lesquereux* .... 192

*Acer minor* Knowlton.
Knowlton, 1902, pl. 14, fig. 2 only
= *Acer bolanderi* Lesquereux .... 192

*Acer minor* Knowlton.
Knowlton, 1926, pl. 27, fig. 4
= *Acer glabroides* Brown ......... 193

*Acer minor* Knowlton.
Berry, 1929, pl. 64, fig. 2
= *Acer glabroides* Brown ......... 193

*Acer negundoides* MacGinitie.
MacGinitie, 1933, pl. 11, figs. 2, 3
= *Acer minor* Knowlton ............ 194

*Acer negundoides* MacGinitie.
Brown, 1935, pl. 69, figs. 9-11
= *Acer minor* Knowlton ............ 194

*Acer negundoides* MacGinitie.
Dorf, 1936, pl. 3, fig. 2
= *Acer minor* Knowlton ............ 194

*Acer negundoides* MacGinitie.
LaMotte, 1936, pl. 12, fig. 3 only
= *Acer minor* Knowlton ............ 194

*Acer negundoides* MacGinitie.
LaMotte, 1936, pl. 12, fig. 4 only
= *incertae sedis* ..................... 203

*Acer negundoides* MacGinitie.
Brown, 1937a, pl. 58, fig. 1
= *Acer minor* Knowlton ............ 194

*Acer negundoides* MacGinitie.
Smith, 1938a, pl. 29, fig. 5
= *Acer minor* Knowlton ............ 194

*Acer negundoides* MacGinitie.
Smith, 1938b, pl. 1, fig. 13
= *Acer minor* Knowlton ............ 194

*Acer negundoides* MacGinitie.
Chaney, 1938c, pl. 6, fig. 2; pl. 7, fig. 1
= *Acer minor* Knowlton ............ 194

*Acer negundoides* MacGinitie.
Chaney, 1944b, pl. 53, figs. 2, 4
= *Acer minor* Knowlton ............ 194

*Acer negundoides* MacGinitie.
Chaney and Elias, 1936, pl. 7, fig. 11 only
= *Acer minor* Knowlton ............ 194

*Acer negundoides* MacGinitie.
Chaney and Elias, 1936, pl. 7, fig. 10 only
= *Gymnocladus dayana* (Knowlton) Chaney and Axelrod ........ 188

*Acer oregonianum* Knowlton.
Knowlton, 1902, pl. 13, fig. 6 only
= *Acer scottiae* MacGinitie ....... 196

*Acer oregonianum* Knowlton.
Berry, 1929, pl. 57, fig. 2; pl. 63; fig. 11
= *Acer minor* Knowlton ............ 194

*Acer oregonianum* Knowlton.
Berry, 1934, pl. 24, fig. 1
= *Acer bendirei* Lesquereux ..... 191

*Acer osmonti* Knowlton.
Knowlton, 1902, pl. 13, fig. 3
= *Acer bendirei* Lesquereux ..... 191

*Acer osmonti* Knowlton.
Chaney, 1927, pl. 17, fig. 6
= *Acer bendirei* Lesquereux ..... 191

*Acer osmonti* Knowlton.
Chaney, 1927, pl. 18, fig. 7 only
= *Acer minor* Knowlton ............ 194

*Acer osmonti* Knowlton.
Chaney, 1927, pl. 18, figs. 1, 3, 5
= *Acer glabroides* Brown ......... 193

*Acer osmonti* Knowlton.
MacGinitie, 1933, p. 62 (part)
= *Acer glabroides* Brown ......... 193

*Acer osmonti* Knowlton.
Brown, 1937a, pl. 58, figs. 16-18
= *Acer bendirei* Lesquereux ..... 191

*Acer osmonti* Knowlton.
Dorf, 1936, pl. 121
= *Acer bendirei* Lesquereux ..... 191

*Acer osmonti* Knowlton.
MacGinitie, 1933, p. 62 (part)
= *Acer columbianum* Chaney and Axelrod ........................ 192

*Acer osmonti* Knowlton.
Oliver, 1934, p. 24
= *Acer glabroides* Brown ......... 193

*Acer osmonti* Knowlton.
Brooks, 1935, pl. 20, fig. 2
= *Acer columbianum* Chaney and Axelrod ........................ 192

*Acer osmonti* Knowlton.
LaMotte, 1936, pl. 12, fig. 6
= *Acer glabroides* Brown ......... 193

*Acer osmonti* Knowlton.
LaMotte, 1936, p. 137 (part)
= *Acer bolanderi* Lesquereux .... 192

cuneate to slightly rounded bases. The marginal teeth are generally few and small, though we are illustrating some specimens showing more numerous and somewhat larger teeth than the norm. The secondaries in this alder are regularly widely spaced and slightly looping above.

It has generally been recognized that A. relatus is similar to modern temperate species of the genus. Such alders as A. maritima (Marshall) Muhlenberg of the eastern United States and A. japonica Siebold and Zuccarini of northern Japan and China (Shantung, Kiangsi provinces) have leaves that are similar to the fossil, as does A. crematostygne Burkhill of central China. All these living species have globose cones, and several similar ones are represented in the Stinking Water material assigned to A. relatus.

We are adding several species from the Mascall and Succor Creek floras to the synonymy of A. relatus, as listed above.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P28), hypotypes nos. 2970, 2971, homeotype no. 2972. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 2965, 2966, homeotypes nos. 2967, 2968, 2969. Succor Creek, Ore.: U. S. N. M.; U. M. M. P.; Carnegie Mus.; U. C. M. P. (loc. P3745). Latah, Wash.-Ida.: U. S. N. M. (Spokane, Whitebird, Grand Coulee, Coeur d'Alene locs.).

### Betula fairii Knowlton

(Plate 21, fig. 10; plate 23, figs. 1, 7)

Betula fairii Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 33, pl. 17, fig. 4, 1926.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 171, pl. 47, figs. 5-7, 1937 (see synonymy).
Betula sp. Oliver, Carnegie Inst. Wash. Pub. 455, p. 18, pl. 3, fig. 5, 1934.
Betula largei Knowlton. Berry, U. S. Geol. Surv. Prof. Paper 170, p. 34, 1931.
Ulmus speciosa Newberry. Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 731 (part), 1898.
Betula heteromorpha Knowlton. Berry, U. S. Geol. Surv. Prof. Paper 170, p. 34, 1931.
Berry, U. S. Geol. Surv. Prof. Paper 185, p. 107 (part), 1934.

A small number of specimens in the Blue Mountains flora, and one in the Mascall, are similar to leaves produced by the living Betula luminifera Blume of eastern Asia; some of the broader leaves also show relationship to B. maximowicziana Blume of China. Other living species in eastern Asia resembling B. fairii include B. albo-sinensis Burkhill and B. utilis D. Don. The modern Asiatic affinities of our Miocene birch are emphasized by the prolongation of the secondaries beyond the edge of the blade to form conspicuous marginal teeth which are separated by subordinate serrations.

Betula luminifera, which seems closest to our fossils, survives today in the forests of northeastern (Kwantung) and eastern (Anhwei, 2000 feet; Chekiang, 1800-4000 feet) China and extends southwestward into Yunnan and westward to Tibet, where it is recorded at elevations of 11,000 feet. Throughout its range it is found with temperate deciduous and coniferous forests which have largely been derived from the Arcto-Tertiary Geoflora. In the warmer, eastern parts of its range it is found in ecotone with warm-temperate forests. In both the Mascall and Latah floras B. fairii lived with species representing this general type of vegetation, as exemplified by members of the Lauraceae. And in the Shangwang flora of northern China the related B. mioluminifera is recorded also with species from both temperate and warm-temperate forests (Chaney and Hu, 1940).

Aside from its Mascall, Blue Mountains, Payette, and Latah occurrences, B. fairii is represented in the Succor Creek flora of the Oregon-Idaho boundary area, where it has been recorded as Betula ? largei (Brooks, 1935). A number of betulaceous leaves from the older Tertiary floras of western North America and Alaska show relationship to B. fairii and to the living B. luminifera. Among these may be mentioned such species as Betula iddingsi Knowlton from Yellowstone (1899, pl. 86, fig. 5) and B. prisca Ettingshausen from Alaska (Hollick, 1936, pl. 50, fig. 3a).

Occurrence. Mascall, Ore.: U. C. M. P. (loc. P3735), hypotype no. 2975. Blue Mountains, Ore.: U. C. M. P. (locs. P3936, P3937), hypotypes nos. 668, 669, 2953, 2973; homeotypes nos 670, 2974. Succor Creek, Ore.: U. C. M. P.; U. M. M. P.; U. S. N. M. Payette, Ida.: U. S. N. M. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird, Coeur d'Alene locs.).

### Betula thor Knowlton

(Plate 23, figures 2-6)

Betula thor Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 35, pl. 17, fig. 3, 1926.
Betula lacustris MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 50, pl. 4, figs. 3, 4 (not fig. 2, which is Alnus hollandiana Jennings), 1933.
Dorf, Carnegie Inst. Wash. Pub. 476, p. 111, pl. 1, fig. 5, 1936.
Smith, Amer. Mid. Naturalist, vol. 25, p. 502, pl. 6, fig. 6, 1941.
Alnus kefersteinii Unger. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 18, 1888.
Alnus kefersteinii ? (Goeppert) Unger. Knowlton, U. S. Geol. Surv. Bull. 204, p. 43, 1902.
Alnus carpinoides Lesquereux. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 170, pl. 48, fig. 5 (not fig. 4,

which is Alnus hollandiana Jennings), 1937.
LaMotte, Carnegie Inst. Wash. Pub. 455, p. 117, pl. 7, fig. 1, 1936.

All the specimens cited above are considered to represent a species of birch having the following characters: shape ovate to ovate-lanceolate, tip acuminate to acute, base obtuse to truncate, margin single-serrate with 2 to 4 large teeth between the secondaries at the middle of the blade, secondaries 5 to 8 in number with the lowest pair marginal in position. Some living alders, notably Alnus sinuata (Regel) Rydberg and A. alnobetula (Ehrhart) K. Koch, show a general similarity in leaf morphology to these fossils. The diagnostic characters which serve to show that the fossils represent birch are the relatively few, single-serrate marginal teeth, as compared with the more numerous biserrate teeth in these alders; the acuminate to acute tip, rather than acute to blunt as in the alders; and the location of the first pair of secondaries well within the blade, as opposed to their near-marginal position in leaves of the alders.

Betula thor is related to a group of species extending from New England and adjacent Canada across interior North America to southwestern Alaska, thence reappearing on the Kuriles and extending southwestward through Japan, Korea, and Manchuria and into Yunnan in southwestern China. In eastern North America B. papyrifera Marshall, which is similar to B. thor, is a common member of the conifer and hardwood-deciduous forests that have many species closely akin to those in the Mascall and related floras. Its western relative, B. occidentalis Hooker, is associated with forests derived from the North-Coast Coniferous, Sierra-Cascade, and Rocky Mountain Components of the West American Element of the Arcto-Tertiary Geoflora. Betula japonica Siebold grows in temperate deciduous and coniferous forests related to those of eastern and western North America, forests which had a common source in the Arcto-Tertiary Geoflora of the Northern Hemisphere.

Although all the specimens under consideration are closely matched by leaves of the papyrifera phylad, a few tend to have a somewhat cuneate base that recalls leaves of the living water birch, B. nigra Linnaeus, of the eastern United States. The figured Mascall specimens (nos. 2976, 2977) as well as one of the homeotypes (no. 2978) show this similarity. However, the leaves of papyrifera have a range of variation including this type as well as the more characteristic obtuse to rounded bases, which are also included in the range of variation of B. thor. The tips of the leaves of B. nigra are blunter than the commonly acuminate tips of B. papyrifera and of the fossils we have identified as B. thor. We therefore believe that clear evidence for the presence of a nigra-type birch in these floras is not yet in hand. The possibility that the species lines leading to these modern birches had not yet been fully separated by Miocene time may explain the general resemblance of some of our fossils to both species. It is evident that additional material from the localities here studied, as well as from new ones yet undiscovered, will be needed to settle this point. In any event, there is no question of the occurrence of typical leaves of a papyrifera birch in these floras.

Betula thor has a close relative in B. bendirei Knowlton from the Bridge Creek flora (Knowlton, 1902, pl. 17, fig. 3). The latter is similar to two of the types of Alnus carpinoides (Lesquereux, 1883, pl. 50, fig. 11; pl. 51, fig. 5), which also closely resemble the leaves of B. thor and those of the modern B. papyrifera phylad. Since our suite of A. carpinoides leaves from Bridge Creek tends to average more slender than the leaves of B. thor, we think the former probably represents a closely related species of the papyrifera phylad. Current studies of the Bridge Creek and related floras by Chaney will indicate more precisely the relationships between the Miocene and the Oligocene species.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P28, P4129), hypotypes nos. 2976, 2977, homeotypes nos. 2978, 2979, 2980. Blue Mountains, Ore.: U. C. M. P. (loc. P3937), hypotype no. 2781. Upper Cedarville, Cal.-Nev.: U. C. M. P. (locs. P97, P115), hypotype no. 790. Trout Creek, Ore.: U. C. M. P. (loc. P275), hypotypes nos. 566, 568, homeotypes nos. 569, 570; U. M. M. P. Payette, Ida.: U. C. M. P. (loc. P3743), hypotype no. 2982. Lower Idaho, Ida.: U. C. M. P. (locs. P635, P637), hypotype no. 1178, homeotype no. 1179. Latah, Wash.: U. S. N. M. (Spokane loc.). Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600).

### Betula vera Brown

(Plate 23, figure 8)

Betula vera Brown, U. S. Geol. Surv. Prof. Paper 186, p. 171, pl. 48, figs. 7-11, 1937.
Betula idahoensis Smith, Bull. Torrey Bot. Club, vol. 66, p. 470, pl. 10, fig. 4, 1939.

A single leaf in the Blue Mountains flora compares well with those of the living Betula lutea Michaux, the yellow birch. Betula lutea is found in moist habitats of the northeastern United States and adjacent Canada, a region where there are a number of other trees and shrubs with close equivalents in the Blue Mountains flora.

Betula vera may be distinguished from B. fairii Knowlton by having uniform, doubly serrate blunt teeth rather than conspicuous marginal teeth opposite the secondaries. Some specimens of B. vera might be confused with Alnus fossilis Newberry; features serving to distinguish them have been discussed on an earlier page.

Although Smith considered B. idahoensis similar to leaves of the living B. lenta Linnaeus, the latter differ from the fossil in having a more slender shape and a truncate to subcordate rather than rounded base.

Since B. idahoensis can be more nearly matched by leaves of B. lutea, as shown by sheets 1684917 and 1580319 in the U. S. National Herbarium, we place it in synonymy under B. vera Brown.

Occurrence. Blue Mountains, Ore.: U. C. M. P. (loc. P3937), hypotype no. 2983. Latah, Wash.: U. S. N. M. (Spokane loc.). Thorn Creek, Ida.: U. M. M. P.

### Carpinus payettensis Smith

Carpinus payettensis Smith, Amer. Mid. Naturalist, vol. 25, p. 501, pl. 7, fig. 4, 1941.
Carpinus grandis Unger. Chaney, Carnegie Inst. Wash. Pub. 346, p. 105, pl. 9, figs. 6, 10, 11 (not figs. 7-9, which are Engelhardtia), 1927.
MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 50, 1933.
Axelrod, Carnegie Inst. Wash. Pub. 553, p. 254, pl. 43, fig. 6, 1944.

Carpinus has been reported from many of the Eocene, Oligocene, and Miocene floras of middle and high latitudes in North America and Eurasia under the name Carpinus grandis Unger (see Hu and Chaney, 1938, p. 32 for some of the valid records). Although it is apparent that not all the recorded fossils are Carpinus, and that some of them probably represent different species of that genus, it is nonetheless evident that Carpinus was one of the more widely distributed members of the Arcto-Tertiary Geoflora.

The material cited above from the western Tertiary floras finds close relationship with the living C. caroliniana Walters, a small tree widely distributed in eastern North America on the margins of streams and swamps. Similarities are also apparent to the leaves of most members of the genus in Eurasia. Since specific relations on the basis of leaves alone are difficult to establish in this genus, it seems best to consider the American species distinct from the Eurasian C. grandis until more fruiting material is at hand for closer comparison.

Occurrence. Trout Creek, Ore.: U. C. M. P. (loc. P275), homeotypes nos. 564, 565. Bridge Creek, Ore.: U. C. M. P. (locs. P132, P3739, P3748), hypotypes nos. 28, 32, 33. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600). Alvord Creek, Ore.: U. C. M. P. (loc. P601), hypotype no. 2107, homeotypes nos. 2106, 2108.

### Ostrya oregoniana Chaney

(Plate 22, figures 8-10; plate 24, figures 10-12)

Ostrya oregoniana Chaney, Carnegie Inst. Wash. Pub. 346, p. 106, pl. 9, fig. 12; pl. 10, figs. 1-4, 1927.
Dorf, Carnegie Inst. Wash. Pub. 476, p. 111, pl. 2, fig. 10, 1936.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 171, pl. 48, fig. 12, 1937.
Arnold, Contr. Univ. Mich. Mus. Pal., vol. 5, p. 84, pl. 1, figs. 2, 3, 1937.
Carpinus pyramidalis Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 18, 1888.
Carpinus grandis ? Unger. Knowlton, U. S. Geol. Surv. Bull. 204, p. 38 (part), 1902.

Hornbeam is fairly common in the Mascall flora, where it is represented by leaves and fruiting material, but its Blue Mountains record is limited to two leaf impressions, and it is unknown at Stinking Water. Leaves of Ostrya oregoniana are strikingly like those of Betula lenta Linnaeus, and it may at times be difficult to separate them, especially if the fossils are fragmentary. As a general basis for distinction, it has been found that leaves of Betula are generally wider at the base and that prominent abaxial tertiaries from the secondaries are rarely as well developed in the upper half of the blade as in Ostrya.

Ostrya oregoniana is closely similar to O. virginiana (Miller) K. Koch, distributed widely over eastern North America from eastern Canada to North Dakota and southward to northern Florida and eastern Texas. Ostrya japonica Sargent is also much like our fossil material. This species ranges from northern Japan (Hokkaido) and Korea southward through the mountains into Szechuan and Hupeh provinces of central China in association with temperate forests closely related to those of eastern North America.

Ostrya oregoniana is known now from a number of western Miocene floras, but in none of these is it an abundant species; most of its records are limited to a few leaves or fruiting bracts. The Upper Cedarville record of this species was based on a fruit (LaMotte, 1936) that is now interpreted as Nyssa, a not uncommon species in that flora.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P4129), hypotypes nos. 2984, 2985, 2986, 2987, homeotypes nos. 2988, 2989, 2990. Blue Mountains, Ore.: U. C. M. P. (loc. P3936), hypotype no. 3001. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.); U. C. M. P. (loc. P635), hypotype no. 1177. Latah, Wash.: U. S. N. M. (Spokane loc.). Succor Creek, Ore.: U. M. M. P. Trout Creek, Ore.: U. M. M. P.

## Family FAGACEAE

### Castanea spokanensis (Knowlton) new combination

(Plate 24, figures 8, 9)

Quercus spokanensis Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 37, pl. 19, fig. 3, 1926.

Castanea castaneaefolia (Unger) Knowlton. Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 35, pl. 18, figs. 7, 8; pl. 19, fig. 1, 1926.
Berry, U. S. Geol. Surv. Prof. Paper 170, p. 34, 1931.
Berry, U. S. Geol. Surv. Prof. Paper 185, p. 108, 1934 (excluding items in synonymy except the Latah C. castaneaefolia).
Castanea orientalis Chaney. Berry, U. S. Geol. Surv. Prof. Paper 154, p. 245, pl. 51, figs. 4, 5, 1929.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 171, pl. 49, fig. 17, 1937.
Unnamed leaf Berry, U. S. Geol. Surv. Prof. Paper 154, pl. 52, fig. 8, 1929.

All the above-cited Latah specimens represent a new species of chestnut, not the Crooked River Castanea orientalis Chaney, as suggested by Berry and Brown. The Latah leaves are generally broader in proportion to length, and have a more deeply scalloped margin and more numerous secondaries which diverge at moderately high angles, whereas C. orientalis is very slender, and has shallower sinuses and fewer secondaries diverging at lower angles.

The Latah specimens, as well as the two leaves from Succor Creek which are figured on plate 24, are similar to leaves of the living C. dentata (Marshall) Borghausen, a large tree of the Appalachian region of the eastern United States.

The relationship of C. spokanensis to C. ? radiata Chaney from Eagle Creek is obscure, for the latter species is represented only by fruits. Berry has placed the Yellowstone C. pulchella Knowlton and Dryophyllum longipetiolatum Knowlton in synonymy under C. castaneaefolia. Castanea pulchella seems more nearly related to C. ungeri Heer (1871, vol. 2, pl. 7, figs. 1-3) from Alaska. MacGinitie (1941, p. 105) has given reason for assigning Dryophyllum longipetiolatum to Castanopsis. The specimens of Castanea ungeri Heer from Rock Corral (Lesquereux, 1883, pl. 52, figs. 1, 3-7) which Berry (1934, p. 108) placed in synonymy under C. castaneaefolia also seem to represent Castanopsis longipetiolatum (Knowlton) MacGinitie.

Occurrence. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird locs.). Succor Creek, U. C. M. P. (locs. P3742, P3746), hypotypes nos. 4428, 4429.

### Castanopsis spokanensis (Brown) new combination

Tetracera spokanensis Brown, U. S. Geol. Surv. Prof. Paper 186, p. 182, pl. 63, fig. 7, 1937.

Brown pointed out that the leaves of Tetracera spokanensis resemble those produced by certain members of the Fagaceae, and noted they are generally similar to those of Quercus nevadensis Lesquereux from Chalk Bluffs (Lesquereux, 1878a, pl. 2, figs. 3, 4). He was nonetheless inclined to regard the material as Tetracera rather than Quercus on the basis of obovate shape, restriction of the recurved teeth to the upper half of the blade, and finer nervation.

Studying the affinities of Q. nevadensis, MacGinitie (1941, p. 108) noted that although its leaves are similar to those produced by such species as Q. glauca Thunberg and Q. hainanensis Merrill, it may nonetheless represent Castanopsis. Examination of the larger-leafed southeast Asian species of the genus shows that his comparison may well be valid. The leaves of Castanopsis fissa Rehder and Wilson resemble those described by Brown as Tetracera spokanensis, with similar obovate shape, curving teeth restricted to the upper half of the blade, and corresponding details of finer nervation. In view of this close relationship we transfer the species to Castanopsis, making the new combination Castanopsis spokanensis (Brown) Chaney and Axelrod. There is much confusion in the reference of modern Asiatic species to Quercus and Castanopsis, and the last word surely has not been said regarding this fossil species.

The Early Tertiary species Castanopsis longipetiolatum (Knowlton) MacGinitie, as represented at Yellowstone and Chalk Bluffs, shows relationship to C. spokanensis but differs from it chiefly in being more slender.

Occurrence. Latah, Wash.: U. S. N. M. (Spokane loc.)

### Fagus idahoensis new name

(Plate 25, figures 1-6)

Fagus washoensis LaMotte. Smith, Bull. Torrey Bot. Club, vol. 66, p. 472, pl. 11, figs. 2, 3, 4; pl. 13, figs. 5, 7, 9, 1939.
Fagus pacifica Chaney. Smith, Amer. Mid. Naturalist, vol. 25, p. 502, pl. 11, fig. 5, 1941.

Description. Leaves ovate to elliptic and slightly asymmetrical, mostly wider below, with acute tips and broadly rounded to acute bases; 2.0 to 7.0 cm. long and 1.0 to 4.0 cm. wide, average mature leaves measuring 4.0 to 5.5 cm. long and 2.5 to 3.0 cm. wide; petiole medium-textured, 4 to 6 mm. long; midrib medium, straight or curved above the middle; 10 to 13 alternate secondaries, thin-textured, straight and subparallel, though occasionally recurved near base, craspedodrome, diverging from midrib at angles of about 50° to 70° in lower part of blade, averaging 40° to 50° in middle; tertiaries irregularly percurrent, enclosing a polygonal mesh which in turn has finer nervilles ending in cross T's; margin serrate; texture medium.

Involucre ovate and asymmetrical, 1.2 cm. long and 1.3 cm. wide, with many slender, curved prickles which may be forked; peduncle 1.4 cm. preserved, thickened above, about 1 mm. wide.

Discussion. Comparison of a large suite of beech leaves from the Thorn Creek flora with Fagus pacifica Chaney (1927) and F. washoensis LaMotte (1936) shows that the Thorn Creek material represents a different species. It may be distinguished from F. pacifica Chaney because the latter species has more slender leaves and larger teeth. Leaves of F. idahoensis are consistently smaller than F. washoensis,[1] and the greater number are widest in the lower third of the blade rather than at or near the middle.

Fagus idahoensis seems most nearly related to F. grandifolia Ehrhardt, a widely distributed tree in eastern North America, though its leaves are 2 to 3 cm. shorter than those of the smallest specimens available for comparison in the University of California Herbarium. It is possible that F. idahoensis may represent a cooler, upland ecotype (Axelrod, 1941) of F. washoensis LaMotte, though in view of the important differences in leaf shape it seems more likely that it is a distinct species.

Occurrence. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600), hypotypes nos. 4430, 4431, 4432, 4433, 5106, 5107.

### Fagus washoensis LaMotte

(Plate 25, figures 7-10)

Fagus washoensis LaMotte, Carnegie Inst. Wash. Pub. 455, p. 119, pl. 8, figs. 2, 3, 5, 1936.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 171, pl. 51, figs. 1-3, 8-10, 1937 (see synonymy).
Fagus pacifica Chaney. Oliver, Carnegie Inst. Wash. Pub. 455, p. 19, 1934,
Brooks, Ann. Carnegie Mus., vol. 24, p. 285, 1935.
Berry, Bull. Torrey Bot. Club, vol. 65, p. 89, 1938.
Aesculus simulata Knowlton. Oliver, Carnegie Inst. Wash. Pub. 455, p. 24, 1934.
Quercus spokanensis Knowlton. Berry, Bull. Torrey Bot. Club, vol. 65, p. 89, 1938.
Ostrya oregoniana Chaney. Berry, U. S. Geol. Surv. Prof. Paper 185, p. 107, 1934.
Ulmus speciosa Newberry. Berry, ibid., p. 110, 1934.

Fagus washoensis is a characteristic member of the Blue Mountains flora. It is represented by only 3 specimens from our Mascall localities and has not been found in the Stinking Water flora. Its greater abundance at Blue Mountains is fully to be expected in view of the cooler, upland habitat there as compared with the warmer, lowland sites in which the Mascall and Stinking Water floras lived.

Among living species F. washoensis LaMotte shows relationship to F. grandifolia Ehrhardt, a widely distributed tree associated with maples, oak, birch, hornbeam, basswood, and hemlock on well drained uplands and slopes in eastern North America. The Asiatic F. longipetiolata Seeman, from Fukien and Hupeh provinces in China, also shows relationship to the fossil species, notably in petiole length, as pointed out by LaMotte (1936, p. 119).

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P4123, P28), hypotype no. 3020, homeotypes nos. 3021, 3022. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotypes nos. 3023, 3024, 3025, homeotypes nos. 672, 673, 693. Upper Cedarville, Nev.-Cal.: U. C. M. P. (locs. P97, P115), holotype no. 796, paratypes nos. 794, 795, hypotypes nos. 788, 801, 803, homeotypes nos. 849-852 incl. Succor Creek, Ore.: Carnegie Mus. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird locs.).

### Quercus bretzi Chaney

Quercus bretzi Chaney, Contr. Walker Mus., vol. 2, p. 171, pl. 12, fig. 4; pl. 13, fig. 3, 1920.
Brown, Jour. Wash. Acad. Sci., vol. 27, p. 508, fig. 7, 1937.

A single leaf in the Mascall flora is similar to the Eagle Creek types of Quercus bretzi, and like them shows relationship to leaves of the living swamp white oak, Q. bicolor Willdenow. Throughout most of its area swamp white oak inhabits the low ground of rich bottomlands, where it is associated with species of oak, maple, hickory, elm, hackberry, ash, tupelo, swamp cypress, and many other plants having close relatives in the Mascall flora.

Aside from its Eagle Creek and Mascall occurrences, Q. bretzi has been recorded only in the Latah flora at Spokane, and in the Lower Ellensburg.

Occurrence. Mascall, Ore.: U. C. M. P. (loc. P3735), homeotype no. 5147. Eagle Creek, Ore.: Walker Mus. (locs. 4, 5), holotype no. 22403, paratype no. 22404. Latah, Wash.: U. S. N. M. (Spokane loc.).

### Quercus columbiana Chaney

(Plate 26, figures 1-4)

Quercus columbiana Chaney, Contr. Walker Mus., vol. 2, p. 170, pl. 13, figs. 1, 2, 1920.
Brown, Jour. Wash. Acad. Sci., vol. 27, p. 508, text figs. 6, 12, 1937.
Quercus boisiensis Smith, Amer. Mid. Naturalist, vol. 25, p. 508, pl. 10, figs. 1, 4, 1941.
Quercus payettensis Knowlton. Smith, ibid., p. 510, pl. 9, figs. 2, 6, 1941.
Quercus bretzi Chaney. Smith, ibid., p. 510, pl. 9, fig. 5; pl. 11, figs. 1, 2, 1941.

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[1] Attention is directed to the fact that the fossils figured by Smith (1939) have been enlarged 1½ times.

*Quercus tuckeri* Smith, ibid., p. 508, pl. 10, fig. 8 only, 1941.
*Quercus mccanni* Berry. Smith, ibid., p. 510, pl. 8, fig. 1, 1941.
Dorf, Carnegie Inst. Wash. Pub. 476, p. 114 (part), 1936.

A number of additional specimens of *Quercus columbiana* in the Eagle Creek collections at the Walker Museum and the University of California show that the following characters are to be added to the description of this species.

*Supplementary description*. Leaves oblanceolate, ovate to obovate, base rounded, truncate, or acute, apex rounded to acute; 6 to 10 secondaries; shallow to moderately deep sinuses separating the rounded to acute simple teeth.

*Discussion*. *Quercus columbiana* was compared originally with leaves of the living *Q. alba* Linnaeus (Chaney, 1920, p. 139), but the leaves of that species differ from the fossils in having deep lobes which may be compound, and a cuneate base. Brown (1937b, p. 508) has suggested a comparison between *Q. columbiana* and some of the western white oaks, but here also there are important differences in the deeper lobing, the frequent tendency to compound lobes, and the smaller number of secondaries. More recently, Chaney (1944c, pp. 342-345) has shown that *Q. columbiana* has closer affinities with certain members of the chestnut oak group. We have compared our large suites of fossil oak leaves of the *Q. columbiana* type in the Mascall, Thorn Creek, Eagle Creek, and Latah (Ginkgo Petrified Forest) floras with living oaks in eastern America and Eurasia, and find that the fossil species shows closest relationship to *Q. aliena* Blume and *Q. fabri* Hance of China and Japan, and to *Q. sessiliflora* Salisbury and its relatives in Europe. In North America *Q. prinus* Linnaeus is the nearest allied oak.

The close resemblance between the types of *Q. boisiensis* Smith and certain European oaks of the *Q. sessiliflora* alliance has been indicated by Smith. We have in our Mascall material a number of leaves much like the Thorn Creek fossils. Furthermore, we have in our collections leaves much like the Thorn Creek specimens identified by Smith as *Q. tuckeri* (part), *Q. payettensis*, *Q. bretzi*, and *Q. mccanni*. On the basis of extended herbarium studies we are inclined to regard all these Thorn Creek fossils as variants of one polymorphic species, *Q. columbiana*. Since all the Thorn Creek material falls within the range of variation of *Q. sessiliflora* and *Q. fabri*, and is similar to our Mascall, Latah, and Eagle Creek material, we are reducing to synonymy the several Thorn Creek fossils listed above. Additional variation displayed by *Q. columbiana* in the Mascall flora is illustrated on plate 26.

*Quercus columbiana* and *Q. winstanleyi* Chaney are obviously closely related (Chaney, 1944c), but we are not yet satisfied that they represent the same species. Some of the Mascall leaves are indistinguishable from the Troutdale types, but the greater number differ in having more rounded bases, which do not appear to be so strongly developed in the Pliocene species. We prefer not to combine these species until more material is collected from other localities, and the relationship of the Miocene to the Pliocene species is more clearly understood.

*Occurrence*. Mascall, Ore.: U. C. M. P. (locs. P28, P3735, P4129), hypotypes nos. 3026-3029 incl. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600). Latah, Ida.: U. S. N. M. (Potlach Creek, Poorman Creek locs.). Eagle Creek, Ore.: U. C. W. M.; U. C. M. P. Lower Idaho, Ida.: U. C. M. P.

### *Quercus dayana* Knowlton

(Plate 24, figures 3-7)

*Quercus dayana* Knowlton, U. S. Geol. Surv. Bull. 204, p. 51, pl. 6, fig. 1, 1902.
*Salix pseudo-argentea* Knowlton, ibid., p. 31, pl. 2, figs. 2-4, 1902.
*Salix perplexa* Knowlton, ibid., p. 31, pl. 2, figs. 5, 6, 8 only, 1902.
*Salix dayana* Knowlton, ibid., pl. 2, fig. 9 only, 1902.
*Sapindus oregonianus* Knowlton, ibid., p. 79, pl. 15, fig. 3, 1902.
*Diospyros elliptica* Knowlton, ibid., p. 83, pl. 16, fig. 5, 1902.
*Andromeda crassa* Lesquereux. Knowlton, ibid., p. 83, pl. 16, fig. 3, 1902.
*Phyllites inexpectans* Knowlton, ibid., p. 86, pl. 16, fig. 6, 1902.
*Salix raena* ? Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 17, 1888.
*Salix raeana* ? Heer. Knowlton, U. S. Geol. Surv., Bull. 204, p. 30, 1902.
*Castanopsis convexa* (Lesquereux) Brooks, Ann. Carnegie Mus., vol. 24, p. 285, pl. 6, fig. 5; pl. 10, figs. 1, 3; pl. 12, figs. 1-6; pl. 13, figs. 4-6; pl. 18, figs. 3-5; pl. 20, fig. 4, 1935 (not *Quercus convexa* Lesquereux).
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 171, pl. 49, figs. 8-11, 1937.
Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 112, pl. 2, fig. 7; pl. 5, fig. 7, 1939.
*Castanopsis consimilis* (Newberry) Brooks, Ann. Carnegie Mus., vol. 24, p. 285, pl. 17, fig. 1, 1935.
*Castanopsis perplexa* (Knowlton) Brown, Jour. Wash. Acad. Sci., vol. 30, p. 348 (reference to *Salix perplexa* Knowlton), 1940.
*Quercus browni* Brooks, Ann. Carnegie Mus., vol. 24, p. 291, pl. 14, figs. 5, 6 only (not figs. 3, 4, 7, 8, which are *Q. hannibali* Dorf), 1935.
*Quercus treleasii* Berry. Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 113, pl. 6, fig. 2, 1939.

*Betula heteromorpha* Knowlton. Brooks, Ann. Carnegie Mus., vol. 24, p. 283, pl. 5, fig. 3 only, 1935.

*Supplementary description*. Leaves variable in outline—broadly or narrowly elliptic-lanceolate, lanceolate, ovate-lanceolate to oval, oblong, and obovate; the tips ranging from subacuminate to acute, obtuse and rounded, tapering to an acute, obtuse, or subcuneate base; leaves 2.0 to 7.0 cm. long and 1.0 to 3.0 cm. broad; petiole usually short, heavy and thick; midrib firm to thick, largely straight though somewhat curving in narrower leaves; 7 to 15 pairs of alternate secondaries, diverging at high to moderate angles, subparallel in many specimens, more wavering and diverging in others, subcamptodrome; intersecondaries moderately developed, somewhat irregular in outward course; tertiaries irregular in pattern, enclosing a relatively coarse, irregular polygonal mesh; margin usually entire, occasional specimens with 1 or 2 small teeth; texture thick to coriaceous.

*Discussion*. The grouping of all the above-listed material into a single species seems warranted by the fact that there is a complete intergrading range of variation in size and shape, coupled with a consistent similarity in the details of venation in the better-preserved specimens. This variation in shape, ranging from relatively narrow oblong to broadly oval leaves with acuminate to rounded tips, is similar to that displayed by leaves of the living *Quercus virginiana* Miller. Where the finer details of venation can be made out, there is no visible difference, both species having an irregular tertiary venation enclosing a relatively coarse and irregular mesh. The chief difference between the leaves of *Q. dayana* and *Q. virginiana* is that the secondaries of *dayana* tend to be somewhat more parallel than those of *virginiana*, and the fossils frequently have 1 or 2 more pairs of secondaries than modern *virginiana* leaves of the same size. These data lead us to the belief that *Q. dayana* probably represents an extinct species closely related to the modern *virginiana* phylad.

In an early phase of this study we believed that *Q. dayana* was most similar to the living maul oak, *Q. chrysolepis* Liebmann. There are many important similarities, including much of the variation in outline, the number of secondaries, their nearly subparallel arrangement, and the thick, heavy petiole. It was for this reason that Axelrod (1950, p. 57) regarded such species as *Q. hannibali*, *Q. browni*, and *Q. traini* as synonyms with *Q. dayana*. This opinion is reversed in the present study, and all fossil leaves that are similar to those of the living *Q. chrysolepis* are considered once again to represent *Q. hannibali* Dorf (Axelrod, 1944d, p. 199). Since there are many resemblances between these species, it seems likely that if a collection included only two or three entire-margined leaves it might not be possible to determine with any degree of certainty whether the material represented *Q. dayana* or *Q. hannibali*, particularly if the finer details of venation were obscure. If the venation is well preserved, however, the leaves can readily be distinguished, because both *Q. hannibali* and *Q. chrysolepis* tend to have a percurrent tertiary pattern as compared with a strongly irregular tertiary pattern in *Q. dayana* and *Q. virginiana*. There also are other differences which, taken as a group, tend to permit the separation of these similar species: on an average the leaves of *dayana* and *virginiana* are commonly oblong to obovate and oblanceolate, as compared with the ovate to oval and commonly lanceolate leaves with tapering apices in *Q. hannibali* and *chrysolepis*; the secondaries of *dayana* are not so strongly subparallel as those of *hannibali*; the tertiaries are often percurrent in *hannibali*, and usually irregular in *dayana*; the secondaries of *dayana* bifurcate more frequently and they are generally irregular, whereas bifurcations of the secondaries are not common in *hannibali*, and are usually straight; on an average the leaves of *dayana* have secondaries diverging at a higher angle than those of *hannibali*, where the norm is near 45°; whereas the secondaries depart straight out from the midrib in *dayana*, in *hannibali* they often have a reverse curve where they join the midrib; whereas any suite of *hannibali* specimens regularly contains both entire and serrate leaves, the latter are rare in a suite of *dayana* specimens, and then the teeth are small and only one or two are developed.

Since *Q. dayana* is represented by scores of leaves in the Mascall flora, and since those that are well preserved show all the typical characters of *dayana*, and since none of them is serrate, it seems most probable that all of them represent *dayana*, and that *Q. hannibali* does not occur there. In the Stinking Water and Succor Creek floras, however, both species are apparently represented; a few of the more poorly preserved specimens cannot be confidently assigned to either species.

Some of the entire-margined leaves of *Q. dayana*, as well as those of *Q. hannibali*, are deceptively like those of *Castanopsis sempervirens* (Kellogg) Dudley; a number of specimens which we consider to represent *Q. dayana* have been assigned to Castanopsis by several investigators during the past two decades. The area of overlap in the characters of these species is chiefly in those leaves which are generally oval to obovate, and in which the secondaries are slightly camptodrome. The principal basis for consistent separation of modern leaves of this type lies in the nature of the tertiary venation, as noted by Brooks (1935). The leaves of *C. sempervirens* commonly have an even mesh as compared with those of *Q. dayana* and *Q. hannibali*, in which a coarse tertiary network (often percurrent in *Q. hannibali* and *chrysolepis*; usually irregular in *Q. dayana* and *virginiana*) encloses the finer mesh. We must emphasize, however, that an oval to obovate or oblong leaf that has slightly arching secondaries cannot be identified as Castanopsis simply because a coarse tertiary pattern is not visible; in the case of the Succor Creek flora, where Castanopsis was first reported in abundance, it is apparent that a number of the specimens are so poorly preserved that examination under a microscope gives the effect of an even mesh, or at least one in which the tertiary veins are not prominently set off from the finer mesh.

During our protracted study of this difficult problem we have examined well over a thousand specimens of Q. dayana, and fully five hundred specimens of Q. hannibali, as well as several tens of specimens that have been considered to be Castanopsis. This material has included very large suites from the Mascall, Stinking Water, Succor Creek, Lower Idaho, Trout Creek, and Thorn Creek floras. Well over 95 per cent of these leaves can readily be assigned either to Q. dayana or to Q. hannibali on the basis of the characters discussed above. Nearly all the specimens which we have examined that purported to be Castanopsis clearly represent oak, and most of them are Q. dayana. The Succor Creek leaves identified as Castanopsis convexa (Lesquereux) Brooks by Brooks (1935) and Smith (1939b) are oaks on the evidence of their tertiary veins, which are prominently set off from the finer mesh; also, the suite of Succor Creek material displays a range of leaf shape much more like that of Q. virginiana than that of C. sempervirens. Examination of the Blue Mountains and Latah specimens which were assigned to Castanopsis by Brown (1937a) shows that they also have the typical coarse and irregular tertiary network characteristic of Q. dayana.

The types of Salix perplexa Knowlton were considered by Brown (1940, p. 348) to represent Castanopsis. Since Axelrod (1939, p. 95) had shown that Quercus convexa, on which Brooks (1935) had based her combinaation Castanopsis convexa (Lesquereux) Brooks, was an oak, Brown proposed the new combination C. perplexa (Knowlton) Brown to replace C. convexa. We believe that the leaves of Salix perplexa are not Castanopsis, but most probably represent Q. dayana. There are several important points of difference between the leaves of S. perplexa and those of C. sempervirens, which has been considered its nearest living relative. The secondaries of S. perplexa are more numerous and more parallel than those of Castanopsis; the secondaries are relatively straight, rather than arching; the tips are acute to obtuse, not regularly rounded and blunt; and the bases are obtuse to nearly truncate, not cuneate as is common in Castanopsis. The details of finer nervation, though not well preserved, appear to be of the strong-tertiary type as in Quercus, not Castanopsis; the fact that these finer veins are not well preserved tends to give the leaves an even-meshed aspect. Since the types of S. perplexa cannot be separated from our large suite of Q. dayana material, we regard them as part of that species.

On the basis of our extended studies we have thus come to the conclusion that convincing evidence of a Castanopsis of the sempervirens type in the Mio-floras of this region is not yet in hand. As stated above, we have placed in synonymy under Quercus dayana Knowlton most of the specimens that had earlier been referred to C. perplexa and C. convexa, though a few leaves seem more properly to represent Q. hannibali.

There are three other fossil species that show relationship to Q. dayana Knowlton and to the living Q. virginiana and its near relatives, Q. fusiformis Small and Q. brandegei Goldman. Quercus mohavensis Axelrod, from the Tehachapi (Axelrod, 1939) and Florissant floras (MacGinitie, 1953), has more slender leaves than Q. dayana and they occasionally have a single marginal tooth, much like the living species Q. brandegei and Q. fusiformis. The leaves of Q. convexa Lesquereux from the Table Mountain (Condit, 1944b) and Tehachapi floras (Axelrod, 1939) generally are more oblong and slender than those of Q. dayana; they show relationship to Q. virginiana, as well as to Q. engelmannii Greene and Q. oblongifolia Torrey. Quercus previrginiana Berry (1916b) from the Citronelle flora of Alabama more nearly resembles the living virginiana than any other fossil species, and may not be distinct from it.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P28, P4129, P4123), hypotypes nos. 3002, 3003, homeotypes nos. O.S. 892, 3004, 3005, 3006, 3038-3043 incl. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotype no. 3012, homeotype no. 3013. Latah, Wash.: U. S. N. M. (Spokane loc.). Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 5108, 3008, homeotypes nos. 3009, 3010, 3011, 3046. Succor Creek, Ore.: U. S. N. M.; U. C. M. P.; Carnegie Mus.

### Quercus eoprinus Smith

(Plate 26, figures 5-7)

Quercus eoprinus Smith, Bull. Torrey Bot. Club, vol. 66, p. 473, pl. 12, figs. 3, 4, 1939.
Smith, Amer. Mid. Naturalist, vol. 25, p. 501, pl.8, fig. 2; pl. 12, fig. 7; pl. 14, fig. 7, 1941.
Quercus spokanensis var. gracilis Berry, U. S. Geol. Surv. Prof. Paper 185, p. 110, pl. 20, figs. 4, 5, 1934.
cf. Quercus horniana Lesquereux. Oliver, Carnegie Inst. Wash. Pub. 455, p. 27, pl. 5, fig. 5, 1934.
Dorf, Carnegie Inst. Wash. Pub. 476, p. 124, 1936.
Castanopsis consimilis (Newberry) Brooks, Ann. Carnegie Mus., vol. 25, p. 285, pl. 6, fig. 2, 1935.
Cercocarpus antiquus Lesquereux. Dorf, Carnegie Inst. Wash Pub. 476, p. 118, 1936.
Oliver, Carnegie Inst. Wash. Pub. 455, p. 22, 1934.

Quercus eoprinus Smith is now known to be abundantly represented in only one Miocene flora of the Columbia Plateau region, the Thorn Creek of southern Idaho. Only 6 specimens have been found in the Blue Mountains flora, and less than 3 each in the

Upper Cedarville, Latah, and Lower Idaho floras. Among the living chestnut oaks, this species seems closest to Q. montana Linnaeus, which ranges from southern Maine and New Hampshire southward to the District of Columbia and along the Appalachian Mountains and their foothills to northern Georgia. It extends westward through New York to southern Illinois and Indiana and through central Kentucky and Tennessee to northern Mississippi, attaining greatest size and maximum abundance in the lower mountains of the Carolinas and Tennessee.

Occurrence. Blue Mountains, Ore.: U. C. M. P. (locs. P3936, P3937), hypotypes nos. 3052, 3053, 706, homeotypes nos. 687, 688, 3054. Upper Cedarville, Cal.: U. C. M. P. (loc. P115), hypotype no. 5109, homeotype no. 5148. Lower Idaho, Ida.: U. S. N. M. (Montour loc.); U. C. M. P. (loc. P637), homeotypes nos. 1216, 1235. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600). Succor Creek, Ore.: U. C. M. P. (loc. P3742).

### Quercus hannibali Dorf

(Plate 24, figure 2; plate 25, figures 11-13)

Quercus hannibali Dorf, Carnegie Inst. Wash. Pub. 412, p. 86, pl. 8, fig. 9 only, 1930.
Axelrod, Carnegie Inst. Wash. Pub. 476, p. 173, pl. 5, fig. 6, 1937.
Axelrod, Carnegie Inst. Wash. Pub. 553, p. 199, 1944.
Quercus chrysolepis Liebmann. Hannibal, Bull. Torrey Bot. Club, vol. 38, p. 337, pl. 5, figs. 2, 9, 1911.
Quercus declinata Dorf. Carnegie Inst. Wash. Pub. 412, p. 88, pl. 8, fig. 12 only, 1930.
Quercus traini MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 53, pl. 5, figs. 1, 2, 1933.
Brooks, Ann. Carnegie Mus., vol. 24, p. 293, 1935.
Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 23, p. 227, 1938.
Quercus browni Brooks, Ann. Carnegie Mus., vol. 24, p. 291, pl. 14, figs. 3, 4, 7, 8, 1935.
Dorf, Carnegie Inst. Wash. Pub. 476, p. 113, pl. 2, fig. 3, 1936.
Axelrod, Carnegie Inst. Wash. Pub. 516, p. 98, 1939.
Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 112, pl. 2, figs. 2-4, 6, 1939.
Smith, Amer. Mid. Naturalist, vol. 25, p. 508, pl. 7, fig. 5, 1941.
Quercus dayana Knowlton. Axelrod, Carnegie Inst. Wash. Pub. 590, p. 57, pl. 2, fig. 9, 1950.
Quercus clarnensis Trelease. Smith, Amer. Mid. Naturalist, vol. 25, p. 506, pl. 9, fig. 3; pl. 11, fig. 4, 1941.
Quercus consimilis Newberry. MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 52, pl. 6, fig. 1 only, 1933.
Castanopsis convexa (Lesquereux) Brooks. Dorf, Carnegie Inst. Wash. Pub. 476, p. 112, pl. 1, figs. 7, 8, 1936.
Odostemon simplex (Newberry) Cockerell. Berry, U. S. Geol. Surv. Prof. Paper 185, p. 112, pl. 23, fig. 2 only, 1934.
Rhododendron idahoensis Smith, Bull. Torrey Bot. Club, vol. 66, pl. 13, figs. 6, 10, 1939.
Cedrela oregoniana (Lesquereux) Brown. Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 115, pl. 3, fig. 7 only, 1939.
Ptelea miocenica Berry. MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 59, pl. 9, fig. 7, 1933.
Diospyros elliptica Knowlton. Smith, Amer. Mid. Naturalist, vol. 25, p. 520, pl. 14, fig. 3, 1941.
Cedrela ? pteraformis (Berry) Brown. Smith, ibid., p. 516, pl. 14, fig. 2, 1941.

The leaves of Quercus hannibali are sufficiently abundant at Stinking Water to make it one of the commoner species of that flora. It has not been recognized in our large collections from the Mascall and Blue Mountains floras. Most of the Stinking Water material is excellently preserved, showing all the details of leaf character, including the finer nervation. The fossil leaves show a variation in size, shape, and marginal characters closely paralleling that of the living maul oak, Q. chrysolepis Liebmann, which we consider its nearest living equivalent. Quercus chrysolepis has a wide ecologic range, from the humid Coast forest in southwestern Oregon and adjacent California to the subhumid parts of the Sierra-Cascade forest, and to the semiarid woodland communities in central and southern California. Many of its associates in the more humid parts of its area have close relatives in the Miocene floras of the Columbia Plateau region.

Although most of the leaves of Q. hannibali are readily identifiable, some of the ovate to oblong specimens may be confused with the leaves of Q. dayana Knowlton, or with those of the living bush chinquapin, Castanopsis sempervirens. On pages 166-167 we have discussed in some detail the ways in which we have distinguished between these species.

Occurrence. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 3044, 3045, 3048, homeotype no. 3047. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), hypotypes nos. 580, 581, 3014, homeotypes nos. 582, 583. Upper Cedarville, Nev.-Cal.: U. C. M. P. (locs. P96, P115), hypotype no. 3049, homeotypes nos. 3015, 3050, 3051. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.); U. C. M. P. (locs. P635, P636, P638), hypotypes nos. 1183, 1184, 1188, homeotypes nos. 1185, 1186, 1187. Succor Creek, Ore.: U. M. M. P.; U. S. N. M.; U. C. M. P. (locs. P3742, P3745, P3746, P3944, P3945, P3946, P3947). Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600).

### *Quercus merriami* Knowlton

(Plate 27, figures 3-8)

*Quercus pseudo-lyrata* var. *angustiloba* Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 17, pl. 11, fig. 2, 1888.

*Quercus merriami* Knowlton, U. S. Geol. Surv. Bull. 204, p. 49, pl. 6, figs. 6, 7; pl. 7, figs. 4, 5, 1902.

We now have a sufficiently large collection of leaves at hand to show that *Quercus merriami* was founded on specimens representing only a part of the range of variation to be found in the leaves of this oak. We therefore present the following supplementary information on the morphology of *Q. merriami*.

*Supplementary description*. Leaves oblong to obovate, rounded or cuneate at base, irregularly and deeply pinnatifid, with 3 to 7 oblique or falcate lobes, the terminal lobe long-acuminate, usually longer than the laterals, the lobes bristle-tipped; length 4.5 to about 13 cm., including a 2-cm. petiole, blades averaging 8 to 10 cm.; width 1.5 to 6.5 cm., averaging about 4 to 5 cm.; petiole long, usually about 2.0 cm., and relatively thin; midrib firm and relatively straight, the alternate secondaries often somewhat recurved; tertiaries obscure, apparently irregular; margin mostly entire, the lobes rarely with subsidiary teeth; texture heavy.

*Discussion*. The leaves of *Q. merriami* are strikingly like those of the living *Q. falcata* Michaux. Our leaf impressions can be duplicated time and again in the normal leaf variation displayed by this species. Leaves of the closely related *Q. pagoda* Rafinesque also resemble *Q. merriami*, but the leaf variation of the fossil species falls more nearly within that displayed by the modern *Q. falcata*. This is a common tree in the Atlantic and Gulf states, extending northward along the coast as far as New Jersey, and up the Mississippi Valley to southern Illinois and Indiana.

As far as we can determine, *Q. merriami* is represented only in the Mascall and Upper Cedarville floras of the western United States, and is still unrecorded in beds of post-Miocene age. Some of the aberrant leaves of *Q. pseudolyrata* Lesquereux in the Latah may be *Q. merriami*, but additional Latah material is needed to make a positive identification.

Brown has placed *Q. ursina* Knowlton in synonymy under *Q. merriami* (Brown, 1937a, p. 172); we consider these leaves close to *Q. merriami* but more properly assignable to *Q. pseudolyrata* Lesquereux on the basis of shape and marginal features.

*Occurrence*. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P4129, P28, P3735, P4123), syntype no. O.S. 846, hypotypes nos. 3070-3074 incl., homeotypes nos. 3075, 3076. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotype no. 3077, homeotype no. 3078.

### *Quercus prelobata* Condit

(Plate 26, figures 8, 9; plate 27, figures 1, 2)

*Quercus prelobata* Condit, Carnegie Inst. Wash. Pub. 553, p. 43, pl. 7, figs. 3, 4, 1944.

*Quercus duriuscula* Knowlton. Dorf, Carnegie Inst. Wash. Pub. 476, p. 114, pl. 2, fig. 8, 1936.

*Quercus tuckeri* Smith, Amer. Mid. Naturalist, vol. 25, p. 508, pl. 10, figs. 6, 7 (not fig. 8, which is *Q. columbiana* Chaney), 1941.

Leaves of *Quercus prelobata* Condit from Remington Hill are much like those of the living *Q. lobata* Nee and *Q. garryana* Hooker of the Pacific coast, and they also resemble *Q. utahensis* Rydberg of the Rocky Mountain region. Relationship is less apparent with *Q. alba* Linnaeus of the eastern United States; that species has leaves of larger dimensions, the bases are tapering and cuneate, and the lobes are directed forward at lower angles.

A large suite of leaves in the Stinking Water flora is referred to *Q. prelobata* on the basis of their close resemblance to leaves of this species in the Remington Hill flora. Similar material is present in the Mascall flora, although the species was not so abundant there as in the Stinking Water Basin. The specimen of *Q. duriuscula* Knowlton from the Lower Idaho flora is indistinguishable from the Remington Hill, Stinking Water, and Mascall material, and we identify it as *Q. prelobata*. Brown (1937b, p. 516) placed this specimen in synonymy under *Q. columbiana*, but, as pointed out above, that species is not related to the western white oaks. Examination of the Thorn Creek flora shows that two of the specimens of *Q. tuckeri* Smith (1941, pl. 10, figs. 6, 7) represent no more than small leaves of *Q. prelobata* Condit. The other (fig. 8), which is the type of the species, has shallow lobes and more numerous secondaries, and we consider it to represent additional variation of *Q. columbiana* Chaney, for it can be matched by leaves of *Q. sessiliflora* and *Q. fabri*.

*Occurrence*. Mascall, Ore.: U. C. M. P. (locs. P3735, P4129), hypotype no. 3030, homeotypes nos. 3031, 3032. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 3033, 3034, 3035, homeotypes nos. 3036, 3037. Lower Idaho, Ida.: U. C. M. P. (loc. P637), hypotype no. 1193. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600).

### *Quercus pseudolyrata* Lesquereux

(Plate 28, figures 1-4; plate 29, figures 1-4; plate 30, figures 1, 4)

*Quercus pseudo-lyrata* Lesquereux, Mem. Harvard Mus. Comp. Zoöl., vol. 6, no. 2, p. 8, pl. 2, figs. 1, 2, 1878.

Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 17, pl. 10, fig. 1, 1888.
Oliver, Carnegie Inst. Wash. Pub. 455, p. 20, pl. 5, fig. 4, 1934.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 172, pl. 50, figs. 7, 8, 1937.
Smith, Amer. Mid. Naturalist, vol. 25, p. 506, pl. 7, fig. 1, 1941.
*Quercus pseudo-lyrata* var. *acutiloba* Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 17, pl. 11, fig. 1, 1888.
*Quercus pseudo-lyrata* var. *brevifolia* Lesquereux, ibid., p. 18, pl. 10, fig. 2, 1888.
*Quercus pseudo-lyrata* var. *latifolia* Lesquereux, ibid., p. 18, pl. 12, fig. 1, 1888.
*Quercus pseudo-lyrata* var. *obtusiloba* Lesquereux, ibid., p. 18, pl. 10, fig. 3, 1888.
*Quercus duriuscula* Knowlton, U. S. Geol. Surv. Bull. 204, p. 50, pl. 8, fig. 2, 1902.
*Quercus ursina* Knowlton, ibid., p. 51, pl. 7, figs. 2, 3, 1902.
Berry, Bull. Torrey Bot. Club, vol. 65, p. 92, text fig. 8, 1938.
*Quercus merriami* Knowlton. Smith, Bull. Torrey Bot. Club, vol. 66, p. 476, pl. 13, fig. 8, 1939.
Smith, Amer. Mid. Naturalist, vol. 25, p. 510, pl. 8, fig. 3, 1941.
*Quercus deflexiloba* Smith, Amer. Mid. Naturalist, vol. 25, p. 506, pl. 8, fig. 4, 1941.

Lesquereux originally compared the types of *Quercus pseudolyrata* to leaves of the modern *Q. lyrata* Walters of the eastern United States. Chaney (1920, p. 167) has pointed out that this comparison is not accurate, for *Q. pseudolyrata* is in reality a black oak. We have re-examined the types, and it is evident that both specimens have the bristle-tipped lobes typical of black oak; these are not shown in the original illustrations, for the tips were not fully cleaned.

Leaves of *Q. pseudolyrata* are variable in size and shape, and we have figured a number of specimens on plates 28 to 30 to show the range of variation. All this material can be closely duplicated by leaves of the living *Q. kelloggii* Newberry of California and the southern Cascades in Oregon, and by *Q. borealis maxima* Michaux of the eastern United States. Such eastern species as *Q. coccinea* Muenchner, *Q. ellipsoides* Hill, *Q. palustris* Muenchner, and *Q. texana* Buckley of the Coccineae group show a general relationship; they regularly have wider sinuses and the lobes are more spreading than in our fossil material. Since one of our Mascall specimens (plate 28, figure 1) ranges toward the *coccinea* type, as does one of the Stinking Water leaves (plate 29, figure 2), it might be argued that members of the *coccinea* alliance are represented in these floras. At present we are inclined to regard these specimens as variants of *Q. pseudolyrata* because we find in our fossil material a gradation from this wide-sinus type to the more typical *pseudolyrata* leaves, and because leaves of the living *Q. kelloggii* and *Q. borealis* also display this range of variation.

In our material from the Stinking Water flora there are black oak leaves with tapering lobes lacking subsidiary teeth. They might well be regarded as a new fossil black oak, yet we have found modern *Q. kelloggii* leaves that closely resemble them. These fossils, one of which is shown on plate 30, figure 1, grade into forms having one or two subordinate teeth (plate 29, figure 3 and plate 30, figure 4) on the lobes. Accompanying this increased serration is a change in the shape of the lobes, from tapering in specimens without teeth on the lobes, to oblong in those with few, to a final obovate and compound conformation in leaves with large teeth (pl. 28, fig. 4). It seems to us that no useful purpose would be served by describing another fossil black oak which is not readily distinguishable in the usual limited material. We are therefore placing all the Stinking Water suite in *Q. pseudolyrata* Lesquereux, but point out that there was possibly a varietal difference between the Mascall and Stinking Water forms, for none of the Mascall specimens has slender, tapering, entire lobes like those found in the Stinking Water flora.

A majority of the Blue Mountains black oak leaves have somewhat broader lobes which show a tendency to bear numerous sublobes. In this respect they resemble the leaves of *Q. kelloggii* as much as or more than those of *Q. borealis maxima.* Leaves of the *kelloggii* type occur also at Thorn Creek, Idaho, and at Remington Hill, California, in deposits which are younger than those of the Blue Mountains. It is possible that in the more upland habitat of the Blue Mountains flora a distinct species of black oak was present, and that we shall ultimately recognize it under a different name. It is also possible, however, that separation of the lines which have produced the modern species, *kelloggii* and *borealis maxima*, had not yet been fully effected, and that all these specimens are properly referable to a single fossil species, *Q. pseudolyrata*, as here indicated. The fact that the more typical leaves of the *kelloggii* type are found in floras of younger (Mio-Pliocene) age seems to suggest that full specific differentiation had not yet been attained during Middle Miocene time. This further supports our reference of all these leaves to a single variable species.

*Occurrence*. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735, P4129, P4123), syntypes nos. O.S. 1796, O.S. 1796a, hypotypes nos. O.S. 841, 3055, 3056, 3057, homeotypes nos. O.S. 839, O.S. 842, O.S. 843, O.S. 844, O.S. 847, O.S. 849, O.S. 851, O.S. 852, O.S. 859, O.S. 865, 3058, 3059, 3060. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotype no. 677, homeotypes nos. 3061, 3062. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 3063-3069 incl. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), homeotype no. 833. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Potlach Creek locs.).

Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600).

### Quercus simulata Knowlton

(Plate 30, figures 2, 3, 5-8; plate 31, figures 1-4)

Quercus simulata Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 728, pl. 101, fig. 4 only; pl. 102, figs. 1, 2, 1898.
  Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 38, pl. 22, figs. 3, 4, 1926.
  Berry, U. S. Geol. Surv. Prof. Paper 154, p. 246, pl. 51, figs. 9-11 only, 1929.
  Berry, U. S. Geol. Surv. Prof. Paper 170, p. 36, 1931.
  MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 53, pl. 6, fig. 2, 1933.
  Berry, U. S. Geol. Surv. Prof. Paper 185, p. 109, pl. 20, fig. 6, 1934.
  LaMotte, Carnegie Inst. Wash. Pub. 455, p. 122, 1936.
  Dorf, Carnegie Inst. Wash. Pub. 476, p. 115, pl. 1, figs. 9, 10, 1936.
  Brown, U. S. Geol. Surv. Prof. Paper 186, p. 173, pl. 50, fig. 1, 1937.
  Smith, Amer. Mid. Naturalist, vol. 25, p. 506, pl. 9, fig. 7, 1941.
Quercus consimilis Newberry. Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 729, pl. 102, fig. 6, 1898.
  MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 52, pl. 5, fig. 5; pl. 6, figs. 5, 6, 8, 1933.
  Oliver, Carnegie Inst. Wash. Pub. 455, p. 20, 1934.
  Brown, U. S. Geol. Surv. Prof. Paper 186, p. 173, pl. 50, figs. 2-5, 1937.
  Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 112, 1939.
Quercus chaneyi Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 38, pl. 22, fig. 1, 1926.
Quercus clarnensis Trelease. Smith, Amer. Mid. Naturalist, vol. 25, p. 506, pl. 7, figs. 2, 6, 1941.
Quercus idahoensis Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 729, pl. 102, fig. 4, 1898.
Quercus obtusa Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 38, pl. 22, fig. 8, 1926.
Apocynophyllum latahense Berry, U. S. Geol. Surv. Prof. Paper 185, p. 263, pl. 60, fig. 4 only, 1929.
Cassia obtusa Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 731, pl. 100, fig. 4 only, 1898.
Castanea orientalis Chaney. Berry, Bull. Torrey Bot. Club, vol. 65, p. 89, 1938.
Castanopsis angustifolia Smith, Amer. Mid. Naturalist, vol. 25, p. 504, pl. 6, figs. 1, 2, 4, 1941.
Castanopsis chrysophylloides Lesquereux. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 121, 1936.
Castanopsis consimilis (Newberry) Brooks, Ann. Carnegie Mus., vol. 24, p. 285, pl. 7, figs. 3, 4; pl. 8, figs. 1-5; pl. 9, figs. 4, 5; pl. 10, figs. 4, 6; pl. 20, fig. 5, 1935.
  Berry, Bull. Torrey Bot. Club, vol. 65, p. 92, fig. 6, 1938.
Castanopsis convexa (Lesquereux) Brooks, Ann. Carnegie Mus., vol. 24, p. 288, pl. 21, fig. 1b, 1935.
Laurus princeps Heer. Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 41, pl. 23, fig. 3, 1926.
Phyllites crustacea Knowlton, ibid., p. 47, pl. 29, fig. 6, 1926.
Rhus merrillii Chaney. Berry, U. S. Geol. Surv. Prof. Paper 154, p. 256, pl. 51, fig. 8, 1929.
Salix elongata O. Weber. Knowlton, U. S. Geol. Surv. Prof. Paper 140, pl. 12, fig. 4, 1926.
Sapindus oregonianus Knowlton. Brooks, Ann. Carnegie Mus., vol. 24, p. 297, pl. 19, fig. 4, 1935.
  LaMotte, Carnegie Inst. Wash. Pub. 455, p. 37, pl. 1, fig. 3; pl. 3, fig. 5, 1935.
Sapindus idahoensis Smith, Amer. Mid. Naturalist, vol. 25, p. 518, pl. 13, fig. 6, 1941.
Sorbus alvordensis MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 57, pl. 9, fig. 4, 1933.
Umbellularia lanceolata Berry. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 127 (part), 1936.
Umbellularia oregonensis Chaney. Oliver, Carnegie Inst. Wash. Pub. 455, p. 21, 1934.
  Brooks, Ann. Carnegie Mus., vol. 24, p. 299, pl. 19, fig. 6, 1935.

Leaves of this characteristic Miocene species are common in the Blue Mountains and Stinking Water floras, and in most of the Middle and Late Miocene floras of the Columbia Plateau region, but have not been identified in our large collections from the Mascall formation. Our herbarium studies tend to show that a suite of Quercus simulata specimens more nearly resembles the leaves of Q. myrsinaefolia Blume and Q. stenophylla Makino of China and Japan than any other living species. Whereas the secondaries of myrsinaefolia regularly are looping, those of simulata tend to be straighter; simulata specimens often tend to have relatively short and thick petioles, in comparison with the long, slender petioles of myrsinaefolia; another point of difference is seen in the fact that many specimens of simulata have a much heavier texture than modern myrsinaefolia leaves. For a time we thought that we could separate out a second species on the basis of heavier, straighter secondaries and short, thicker petiole; such selected specimens (see plates 30 and 31) are similar to Q. gilva Blume, Q. glauca Thunberg, and Q. delavayi Franchet of central and southern China and Japan. Since there appears to be a complete gradation between such specimens and those of the usual simulata type, we believe that at present we cannot consistently differentiate them. When larger and more complete modern and fossil collections are available for comparison, it may be possible to demonstrate conclusively that more than one species is represented in the material we have assigned to *Q. simulata*. Nonetheless, the possibility remains that these closely related modern species showing relationship to *Q. simulata* were not yet fully differentiated in the Miocene, and for this reason *Q. simulata* might be expected to show relationship to more than one living oak.

*Quercus simulata* has been confused with *Q. consimilis* from the Bridge Creek flora (Newberry, 1898). On the basis of a comparison of numerous Bridge Creek specimens of *Q. consimilis* with large suites of *Q. simulata* leaves from the Payette, Blue Mountains, Stinking Water, Trout Creek, Thorn Creek, Succor Creek, and Upper Cedarville floras, we conclude that they are distinct and rather easily distinguishable species. *Quercus consimilis* regularly has very narrow, serrate leaves, types we have yet to find in *Q. simulata*; where leaves of *Q. simulata* are narrow they are always entire-margined. Serrate leaves of *Q. consimilis* commonly have teeth well below the middle of the blade, a feature rarely seen in *Q. simulata*. Entire leaves are exceedingly rare in a suite of *Q. consimilis* specimens, but are quite common in *Q. simulata*. Another important difference is that most of the leaves of *Q. consimilis* have thicker secondaries than those of *Q. simulata*.

Occurrence. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotypes nos. 674, 3019, 5110-5113 incl., homeotypes nos. 675, 676, 678, 679, 5114, 5115. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 5116, 5117, 5118. Upper Cedarville, Cal.-Nev.: U. C. M. P. (locs. P79, P115), homeotypes nos. 163, 171, 803, 834, 835, 840, 842, 5259. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), hypotypes nos. 572-576 incl., 579. Payette, Ida.: U. S. N. M.; U. C. M. P. (loc. P3743). Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird, Coeur d'Alene locs.). Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.); U. M. M. P.; U. C. M. P. (locs. P635, P636, P637, P638), hypotypes nos. 1197, 1198, 1200, 5149; homeotypes nos. 1188, 5257, 5258. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600). Succor Creek, Ore.: U. S. N. M.; U. M. M. P.; U. C. M. P. (locs. P3742, P3743, P3745, P3746), hypotype no. 5260.

### *Quercus smileyana* new species

(Plate 24, figure 1)

Description. Leaves lanceolate to oblong-lanceolate; length 11 to 15 cm. (estimated), width 2.8 to 4.0 cm., greatest breadth near middle of blade, tip acute, base acute to apparently obtuse; midrib firm, straight; about 6 mm. of petiole preserved; widely spaced alternate secondaries diverging at angles of 35° to 50°, slightly wavering in their outward course, occasionally bifurcating in outer half of blade; well developed intersecondaries, often diverging at higher angles than the secondaries; tertiaries obscurely preserved, apparently forming irregular polygons; margin entire; texture subcoriaceous.

Discussion. Three leaves in the Mascall flora are similar to those produced by the shingle oak, *Quercus imbricaria* Michaux of the eastern United States. The two slender leaves are nicely matched by sheets 986503 and 5753 in the University of California Herbarium, and the broader specimen finds a good match on sheet 942635. Shingle oak is a tall tree that attains best development on rich soils both in the uplands and on fertile bottomlands. It is one of the commoner trees in the lower Ohio Basin, a region having many close equivalents of the Mascall flora. The general rarity of *Q. smileyana* in the Mascall flora may well be attributed to its site on better-drained slopes somewhat removed from the swamp flora which dominated at the immediate site of deposition.

This oak is named in honor of Charles J. Smiley, who has recently re-examined the oaks in our large collections during his current study of the Ellensburg flora, and has pointed out certain critical relations not noted earlier.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P4129), holotype no. 3016, homeotypes nos. 3017, 3018. Blue Mountains, Ore.: U. C. M. P. (loc. P3937).

## Family ULMACEAE

### *Celtis dayana* new species

(Plate 32, figures 6, 7)

Description. Leaves oblanceolate and inequilateral, base rounded and suboblique, apex long-tapering; blade 4.5 to 5 cm. long, about 2 cm. wide near middle; petiole up to 2.0 cm. long, slender; midrib medium-textured below, thin above; a pair of basal primaries diverge at angles of 25° to 55° from midrib within blade at point of petiole attachment, with irregular abaxial secondaries diverging from the basal pair, remaining secondaries diverging from midrib at moderate angles in middle of blade and as low as 20° in upper part, curving upward in broad loops; tertiaries irregular; margin entire; texture medium thin.

Discussion. This new species is founded on two leaf impressions in the Mascall flora. In their thin texture and entire margins, the leaves seem closely related to *Celtis mississippiensis* Bosc, a small tree found around the borders of lakes and in the rich bottomlands of the lower Mississippi Valley, ranging northward to southern Illinois and Indiana. It is a common associate of the Taxodium-Nyssa community, which is represented in the Mascall flora by many similar species.

*Celtis dayana* differs from *C. kansana* Chaney and Elias of the Pliocene floras of the High Plains (Chaney and Elias, 1936) and California (Axelrod, 1944b, 1944c; Condit, 1944b) in having an entire margin, a thinner texture, and a more slender shape. Celtis dayana differs from the Bridge Creek C. obliquifolia Chaney (1925c) in its smaller size and thinner texture, and in having tertiaries that are irregular rather than percurrent at essentially right angles to the axis of the leaf.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P28, P3735), holotype no. 3000, paratype no. 3079.

### Ulmus newberryi Knowlton

Ulmus newberryi Knowlton, U. S. Geol. Surv. Bull. 204, p. 54, pl. 9, fig. 4, 1902.
Ulmus speciosa Newberry. Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 39, pl. 18, fig. 6, 1926.
Berry, U. S. Geol. Surv. Prof. Paper 154, p. 247, 1929.
Berry, U. S. Geol. Surv. Prof. Paper 170, p. 34, 1931.
Ulmus fruit Berry, U. S. Geol. Surv. Prof. Paper 154, p. 247, pl. 51, fig. 1; pl. 64, figs. 3, 4, 1929.

Knowlton originally pointed out that the leaves of Ulmus newberryi from Bridge Creek differ from those of U. speciosa, also from Bridge Creek, in having a more slender shape and a strongly asymmetrical base. We may add that U. speciosa includes a number of nearly oval leaves in its range of variation, a character not found in U. newberryi. Examination of the large suite of leaves representing these Bridge Creek elms in the collections at the University of California shows that the material can readily be separated into two categories, and that there is scarcely any gradation between them, as Knowlton has indicated (1902, p. 53). We are therefore resurrecting the species of U. newberryi, which has been in synonymy under U. speciosa for some years.

Ulmus newberryi can be matched most closely by leaves and fruits of the living U. americana Linnaeus, a widely distributed tree in eastern North America. Knowlton (1902, p. 54) has correctly pointed out that U. newberryi is more nearly related to U. californica Lesquereux than to U. speciosa. The principal differences between U. newberryi and U. californica are that U. californica has smaller leaves with smaller teeth. This trend toward smaller leaves and suppressed teeth in the U. newberryi - U. californica phylad has been correlated with the trend toward lessened rainfall and increasing ranges of temperature in the Pacific region in post-Miocene time (Chaney, 1944a, pp. 15-17).

The leaf assigned to U. speciosa in the Lower Idaho flora (Dorf, 1936, p. 116) is now identified as U. californica, for it is smaller than the Bridge Creek and Latah leaves, and is of the size of the type material from Table Mountain.

Occurrence. Bridge Creek, Ore.: U. S. N. M.; U. C. M. P. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird, E. of Arrow Jct. locs.).

### Ulmus paucidentata Smith

(Plate 31, figures 9-12)

Ulmus paucidentata Smith, Bull. Torrey Bot. Club, vol. 66, p. 478, pl. 13, figs. 2-4, 1939.
Smith, Amer. Mid. Naturalist, vol. 25, p. 512, pl. 10, fig. 2; pl. 13, figs. 4, 9, 1941.
Ulmus californica ? Lesquereux. Knowlton, U. S. Geol. Surv. Bull. 204, p. 55 (part), 1902.

The Mascall leaves of Ulmus paucidentata Smith are easily separable from those of U. speciosa Newberry, the commonest elm in the flora, on the basis of their smaller size and slender shape. Ulmus paucidentata has leaves and fruits similar to those produced by the modern U. alata Michaux, a widely distributed tree in the central Mississippi Basin, ranging from Indiana and Tennessee southward to Florida and Georgia, and westward to Oklahoma. Ulmus pumila Linnaeus, a common elm in China, also resembles U. paucidentata, but differs in its regularly symmetrical leaves with acuminate tips.

Ulmus paucidentata is related to U. tanneri Chaney from Eagle Creek (Chaney, 1920, pl. 14, figs. 1, 2), but the leaves of that species are larger and do not seem to be so asymmetrical as those of U. paucidentata. Further collections from Eagle Creek may show that U. tanneri includes all the variation displayed by the Mascall and Thorn Creek material, but until such leaves are collected it seems best to refer our Mascall fossils to the Thorn Creek species, which they more nearly resemble.

Ulmus paucidentata is known from only three Miocene floras, the Mascall, Succor Creek, and Thorn Creek. Leaves identified as Ulmus cf. tanneri Chaney in the Pliocene Sonoma and Diablo floras of the San Francisco Bay region (Axelrod, 1944d, p. 200; 1944e, p. 213) differ from U. paucidentata and U. tanneri in being consistently smaller. It is probable that when larger collections are available they will show that the Pliocene elm is sufficiently distinct to be designated by a new name. The only other American fossil elm that resembles U. paucidentata is U. floridana Berry from the Alum Bluff flora (Berry, 1916a, pl. 9, figs. 5-7), which also is like U. alata of the eastern United States.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (all localities), hypotypes nos. 3087, 3088, 3089, homeotypes nos. 3086, 3090, 3091. Succor Creek, Ore.: U. C. M. P. (loc. P3746), hypotype no. 3092. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600).

### Ulmus speciosa Newberry

(Plate 32, figures 1-5)

Ulmus speciosa Newberry, Proc. U. S. Nat. Mus., vol. 5, p. 507, 1883.
Newberry, U. S. Geol. Surv. Monog. 35, p. 80, pl. 45, figs. 2-4, 8, 1898.
Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 731 (part), 1898.
Chaney, Contr. Walker Mus., vol. 2, no. 5, p. 171, 1920.
LaMotte, Carnegie Inst. Wash. Pub. 455, p. 124, 1936.
Ulmus pseudo-americana Lesquereux, Rept. U. S. Geol. Surv. Terr., vol. 8, p. 249, pl. 54, fig. 10, 1883.
Ulmus plurinervia Unger. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 18, 1888.
Betula ? dayana Knowlton, U. S. Geol. Surv. Bull. 204, p. 41, pl. 4, fig. 4, 1902.

A large suite of elm leaves, from 4 to 14 cm. in length, has been collected from the Mascall localities, and a smaller number is present in our material from Stinking Water. Comparison of these specimens with Ulmus speciosa leaves from Bridge Creek, the type locality for the species, shows that no basis can be found for separating them, and we therefore identify our material as U. speciosa.

The leaf variation displayed by this species generally resembles that shown by the modern U. americana Linnaeus. An even closer comparison can be made, however, with leaves of the modern U. fulva Michaux and U. racemosa Thomas of the eastern United States. Leaves of these living species, and those of U. speciosa, differ consistently from those of U. americana in having more nearly oval outlines, rounded bases with less marked asymmetry, and less attenuated apices. As pointed out above, U. newberryi Knowlton is more nearly related to the living U. americana than is U. speciosa.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (all localities), hypotypes nos. 2896, 3080, 3081, 3082, 3296, homeotype no. 3083. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotype no. 3084, homeotype no. 3085. Succor Creek, Ore.: U. M. M. P. Trout Creek, Ore.: U. M. M. P. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), homeotypes nos. 836, 5119, 5120. Payette, Ida.: U. S. N. M. Latah, Wash.: U. S. N. M. (Grand Coulee loc.)

### Zelkova oregoniana (Knowlton) Brown

(Plate 31, figures 5-8)

Zelkova oregoniana (Knowlton) Brown, U. S. Geol. Surv. Prof. Paper 186, p. 173, pl. 51, figs. 11-15, 1937 (see synonymy).
Castanea atavia Unger. Lesquereux, Rept. U. S. Geol. Surv. Terr., vol. 8, p. 247, pl. 52, fig. 2, 1883.
Fagus castaneaefolia Unger. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 18, 1888.
Quercus horniana Lesquereux. Knowlton, U. S. Geol. Surv. Bull. 204, p. 52, pl. 8, fig. 1, 1902.
Myrica oregoniana Knowlton, ibid., p. 33, pl. 3, fig. 4, 1902.
Fagus ? sp. Knowlton, ibid., p. 43, 1902.
Ulmus californica Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 18, 1888.
Ulmus californica ? Lesquereux. Knowlton, U. S. Geol. Surv. Bull. 204, p. 55 (part), 1902.
Celastrus dignatus Knowlton, ibid., p. 71, pl. 11, fig. 5, 1902.
Ulmus speciosa Newberry. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 124 (part), 1936.

Typical Zelkova leaves are well represented in the Mascall collections, but have not been encountered in the Blue Mountains and Stinking Water floras. The specimens show a wide range of variation in size and shape, ranging from lanceolate to ovate in outline and having long tips and cordate, rounded, and in some cases slightly asymmetrical bases. The length ranges from 4 cm. to over 12. We consider all this material to represent one variable species. Leaf variation displayed by such species as Zelkova serrata Maximowicz and Z. ulmoides Schneider of China and Japan matches that of the Mascall leaves quite closely.

Leaves of this sort were for many years referred to Planera, and show some resemblance to the living Planera aquatica (Walters) Gmelin, which may rarely have leaves with simply-serrate margins (see sheet 906348, U. C. Herbarium. Our fossil leaves can readily be distinguished from those of the water elm by their larger size, more slender shape, more numerous secondaries, and much larger, simply-serrate teeth.

Zelkova is now known from many localities in the western United States. In two floras, the Mascall and the Latah, it was a fairly common species, but it is represented by only a few specimens in the Republic, Upper Cedarville, Payette, Succor Creek, Eagle Creek, and Molalla floras; it survived into the early Pliocene in Oregon (Chaney, 1944c). Zelkova ungeri Kovats is a related species that has been recorded widely at middle and high latitudes in the Northern Hemisphere in deposits ranging from Eocene to Pliocene in age (Hu and Chaney, 1938, p. 41).

Of the fossils listed in synonymy above, the specimens assigned by Lesquereux to chestnut and beech represent no more than typical large leaves of Zelkova. Likewise, the fossils assigned to five different genera by Knowlton all represent a biologic unit and are typical of the species Z. oregoniana.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735, P3737, P4129, P4123), hypotypes nos. O.S. 1799, 3094, 3095, 3096, homeotypes nos.

3093, 3097, 3098. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotype no. 3099, homeotype no. 797. Latah, Wash.: U. S. N. M. (Spokane loc.). Payette, Ida.: U. S. N. M. Succor Creek, Ore.: U. S. N. M.

### Family NYMPHAEACEAE

#### Nymphaeites nevadensis (Knowlton) Brown

(Plate 32, figures 8, 9; plate 33, figures 9, 10)

Nymphaeites nevadensis (Knowlton) Brown, Jour. Wash. Acad. Sci., vol. 27, p. 509, fig. 10, 1937 (see synonymy).

Specimens of the pond lily are rare in the Mascall and are unrecorded in the Stinking Water flora proper. However, impressions of detached root scars of rhizomes are common in the lake beds at locality P4121, which are considered to be somewhat younger. Although remains of aquatic vegetation are abundant here, we have not been able to identify with certainty any material that might be interpreted as leaves of Nymphaea. Leaves of water lily are never common in fossil deposits, chiefly because their thin, spongy texture makes them less readily preserved than the more durable leaves of oak, avocado, or hickory. Several specimens representing rhizomes and stems of water lily show the rootlets and root scars in position. Isolated root scars from such stems have been recorded widely in deposits of Miocene and Pliocene age in the western United States. The specimen shown as figure 9 on plate 32 is a horizontal rhizome with rootlets and root scars; figure 9 on plate 33 shows the base of a stem which was attached directly to the substratum.

Occurrence. Mascall, Ore.: U. C. M. P. (loc. P28), hypotype no. 3100. Stinking Water, Ore.: U. C. M. P. (loc. P4121), hypotypes nos. 3101, 3102, 3103. Trout Creek, Ore.: U. M. M. P., U. C. M. P. (loc. P275), hypotypes nos. 590, 591. Payette, Ida.: U. S. N. M.

### Family CERCIDIPHYLLACEAE

#### Cercidiphyllum crenatum (Unger) Brown

(Plate 33, figures 7, 8)

Cercidiphyllum crenatum (Unger) Brown, Jour. Paleontol., vol. 13, p. 488, pl. 68, figs. 1, 6, 8-10, 1939 (see synonymy).
Paliurus colombi Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 16, 1888.
Grewia crenata (Unger) Heer. Knowlton, U. S. Geol. Surv. Bull. 204, p. 80, 1902.

Katsura is represented by only 5 specimens in all known Mascall collections that have been made since the locality was first discovered. Cercidiphyllum was evidently a rare tree near sites of deposition in the Mascall area, and it is likewise uncommon in most of the younger Miocene floras of this region; only locally in the Ellensburg region of central Washington, in beds apparently equivalent to the Latah, is Cercidiphyllum known to be abundant (U. C. Mus. Pal. collections). Cercidiphyllum seems to have attained optimum development in the Columbia Plateau area in the Oligocene, to judge from its abundance in the Bridge Creek and Lower Cedarville floras.

The fossil species shows close relationship to the living Cercidiphyllum japonicum Siebold and Zuccarini, which has a discontinuous distribution in eastern Asia, occurring in Japan and in the middle Yangtse basin.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P28, P4129, P4123), hypotype no. 3104, homeotypes nos. 3105, 3106, 3107. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), homeotype no. 837. Lower Idaho, Ida.: U. C. M. P. (locs. P635, P638), homeotypes nos. 1209, 1210.

### Family MAGNOLIACEAE

#### Magnolia corrallina new name

Laurus princeps Heer. Lesquereux, Rept. U. S. Geol. Surv. Terr., vol. 8, p. 250, pl. 58, fig. 2, 1883.
Magnolia californica Lesquereux. Condit, Carnegie Inst. Wash. Pub. 476, p. 260 (part), 1938.

As indicated below in our discussion of Persea pseudocarolinensis Lesquereux, the specimen of Magnolia from Corral Hollow recorded by Condit (1938) as Magnolia californica Lesquereux requires a new name because the types of M. californica Lesquereux represent Persea and Pongamia. The specimen figured by Lesquereux (1883, pl. 58, fig. 2) as Laurus princeps from Corral Hollow also represents M. corrallina, and not M. dayana Cockerell as suggested by Brown (1937a, p. 175).

The Corral Hollow specimens appear to be similar to those recorded from the Latah flora under such names as Magnolia dayana Cockerell, Laurus princeps Heer, and Laurus grandis Lesquereux, and listed in synonymy under M. dayana Cockerell by Brown (ibid.). However, the Latah material differs from the types of M. dayana Cockerell from the Chalk Bluffs flora (MacGinitie, 1941) in several ways. Leaves of the Chalk Bluffs species tend to be oblanceolate to oblong-lanceolate, as compared with the long-elliptic to long-oval leaves of M. dayana at Latah; the base of the leaves of M. dayana is often strongly decurrent, a feature not present in the Latah specimens; and the types of M. dayana have a membranaceous rather than a coriaceous texture. Whereas leaves of M. dayana from Chalk Bluffs show relationship to those produced by the living M. tripetala Linnaeus, those of the Latah are more nearly like those of M. grandiflora Linnaeus, though the norm tends toward more slender leaves. When additional material of M. corrallina becomes available for study, it may be possible to demonstrate that the Latah specimens of M. dayana should be placed in synonymy with it.

Magnolia latahensis (Berry) Brown, also from the Latah flora (Brown, 1937a, p. 175, see synonymy), resembles the leaves of M. grandiflora more closely than does M. dayana of the Latah flora, and may well represent a distinct species. Magnolia latahensis does not seem to differ appreciably from the Neroly M. corrallina, but since it is also represented by limited material, it seems best not to merge them in synonymy at present.

Occurrence. Neroly, Cal.: U. C. M. P. (Lesquereux's Corral Hollow locality, loc. P361), holotype no. 1927, homeotype no. 1254.

### Family BERBERIDACEAE

### Mahonia reticulata (MacGinitie) Brown

(Plate 33, figures 1, 4)

Mahonia reticulata (MacGinitie) Brown, U. S. Geol. Surv. Prof. Paper 186, p. 175, pl. 52, fig. 4, 1937 (see synonymy).
Odostemon simplex (Newberry) Cockerell. Dorf, Carnegie Inst. Wash. Pub. 476, p. 118, 1936.
Berry, U. S. Geol. Surv. Prof. Paper 185, p. 112, pl. 23, fig. 1 (not fig. 2, which is Quercus hannibali (Dorf), 1934.

Seven leaflets in the Stinking Water flora are essentially identical with certain Trout Creek specimens of Mahonia reticulata in all details of size, margin, and base. The Stinking Water specimens have only 2 to 5 marginal teeth, separated by broad, shallow sinuses. These might at first be confused with leaflets of M. simplex, but may be distinguished from that species in having a normal pinnate venation instead of a pair of prominent primaries extending distally for one-third to one-half the length of the blade. Another difference is that the sinuses of M. simplex are regularly deep, whereas those of M. reticulata are shallow.

The record of this species in the Blue Mountains flora is limited to the fragmentary specimen collected and figured by Brown (1937a). Judging from its absence from our large collections at that locality, we conclude that it was a rare plant in that region in Miocene time.

Among modern species of the genus, M. reticulata shows relationship to M. repens (Lindley) Don and M. nervosa (Pursh) Nuttall. These are common shrubs in the Sierra-Cascade, Coast, and Rocky Mountain forests of the Far West, forests which have many species related to those in the Miocene of the western United States.

Occurrence. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.). Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 3108, 3109, homeotype no. 3110. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), lectotype no. 584, hypotypes nos. 585, 586, 587. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.); U. C. M. P. (locs. P635, P636), homeotypes nos. 1211, 1212, 1213. Succor Creek, Ore.: U. M. M. P.

### Mahonia simplex (Newberry) Arnold

(Plate 33, figures 2, 3, 5, 6)

Mahonia simplex (Newberry) Arnold, Contr. Univ. Mich. Mus. Pal., vol. 5, no. 4, p. 58, pl. 1, figs. 1-3, 6, 7; pl. 2, figs. 1, 2, 1936 (see synonymy).

A total of 10 leaflets, 4 from the Mascall flora and 6 from the Stinking Water, make up the record of this common Miocene species in these floras. Mahonia simplex more closely resembles the leaflets produced by the modern M. beali Carrière of east-central China than those of any other species yet noted. Its leaflets vary from the commonly figured oval simplex form to a slender, attenuated form, regularly terminal in position; our fossils include both types, as illustrated on plate 33.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P4129), hypotypes nos. 3111, 3112. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotypes nos. 3113, 3114. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), hypotype no. 588. Latah, Wash.-Ida.: U. S. N. M. (Elk River loc.). Succor Creek, Ore.: U. M. M. P.; U. S. N. M.

### Family LAURACEAE

### Laurophyllum merrilli Chaney and Sanborn

(Plate 33, figure 11)

Laurophyllum merrilli Chaney and Sanborn, Carnegie Inst. Wash. Pub. 439, p. 72, pl. 17, figs. 1, 3, 1933.
MacGinitie, Carnegie Inst. Wash. Pub. 465, p. 138, pl. 6, fig. 5, 1937.

A single leaf and its counterpart in the Mascall flora are indistinguishable from the Weaverville and Goshen specimens. Laurophyllum merrilli resembles leaves of the modern Machilus ichangensis Rehder and

Wilson of eastern and southeastern China, but an even closer relationship appears to be shown by leaves of Phoebe sheareri Gamble of the same region. Leaf variation shown on sheet 281247 in the University of California Herbarium closely duplicates the Goshen and Mascall specimens. The somewhat broader Weaverville leaf is well matched by leaves on sheet 231853, which also includes the leaf variation of the Goshen and Mascall fossils. When additional fossil material becomes available for comparison it may prove desirable to transfer L. merrilli to Phoebe.

Laurophyllum in the Mascall flora is clearly a relict. In the late Eocene Goshen flora, where the genus is first recorded on the Pacific coast, its associates were chiefly subtropical plants. It also occurs with numerous subtropical genera in the Oligocene Weaverville flora, but at this later date a number of warm-temperate to temperate plants were associated with it. Among them were Taxodium dubium, Platanus dissecta, and Nyssa hesperia, common plants in both the Weaverville and Mascall floras. This diverse range of Laurophyllum merrilli, so far as ecological relations in time are concerned, corresponds closely to the present occurrence of its nearest equivalent. Phoebe sheareri now ranges from the subtropical coast of southeast China northward into the more temperate provinces of the Yangtse basin.

Occurrence. Mascall, Ore.: U. C. M. P. (loc. P28), hypotype no. 3116. Goshen, Ore.: U. C. M. P. (loc. P3932), holotype no. 206, hypotype no. 207. Weaverville, Cal.: U. C. M. P. (loc. P141, hypotype no. 1030, homeotype no. 1031.

### Lindera oregoniana (Knowlton) new combination

(Plate 34, figure 5)

Laurus oregoniana Knowlton, U. S. Geol. Surv. Bull. 204, p. 58, pl. 9, fig. 3 only, 1902.
Phyllites oregonianus Knowlton. MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 68, pl. 7, fig. 2, 1933.
Phyllites mascallensis Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, p. 100 (part), 1937.

Supplementary description. Leaves slender, long-lanceolate; 9.5 to 14 (estimated) cm. long and 1.8 to 3.2 cm. wide; tapering above to a long acuminate tip, and below to a narrowly cuneate base; petiole heavy, apparently short; leaf blade widest near middle, with 6 to 7 pairs of alternate secondaries diverging at 10° to 15°, slightly arching, passing upward for relatively long distances, camptodrome; fine tertiary mesh; margin entire; texture medium thick.

Discussion. These leaves are very similar to those of the living Lindera angustifolia Cheng, as is shown by comparison with sheets 305746 and 992379 in the University of California Herbarium. Lindera angustifolia is a large shrub ranging from the south China coast (Kwangtung) northward into the Yangtse basin (Kiangsi, Hupeh, Chekiang). It frequently forms dense thickets in the ecotone from warm-temperate to temperate forests in this region, where it is found commonly with many plants that have near relatives in the Mascall and related floras.

The leaf figured by Knowlton (1902, pl. 16, fig. 1) as Phyllites oregonianus may well represent another specimen of Lindera oregoniana. Since the specimen cannot be found, and because it is poorly illustrated, it cannot be evaluated accurately. In any event, Arnold applied the specific name mascallensis to this leaf, as well as to the specimen figured by MacGinitie (1933, pl. 7, fig. 2) as P. oregonianus Knowlton. This was necessary because the name Phyllites oregonianus Knowlton had earlier been used by Knowlton for a species in the Cascade Locks flora. Since MacGinitie's specimen represents Lindera, it is placed in synonymy here, together with the new name proposed for it by Arnold.

Occurrence. Mascall, Ore.: U. C. M. P.(loc. P28), holotype no. O.S. 867, hypotype no. 3117. Trout Creek, Ore.: U. C. M. P. (loc. P275), hypotype no. 636, homeotype no. 637.

### Persea pseudocarolinensis Lesquereux

(Plate 34, figures 1, 3, 4, 6)

Persea pseudocarolinensis Lesquereux, Mem. Harvard Mus. Comp. Zoöl., vol. 6, no. 2, p. 19, pl. 7, figs. 1, 2, 1878.
  Sanborn, Carnegie Inst. Wash. Pub. 465, p. 20, pl. 5, fig. 3, 1935.
  Potbury, Carnegie Inst. Wash. Pub. 465, p. 68, pl. 6, figs. 2, 3, 1935.
  MacGinitie, Carnegie Inst. Wash. Pub. 534, p. 119, pl. 21, figs. 1-3, 5, 1941.
Persea princeps Schimper. Condit, Carnegie Inst. Wash. Pub. 476, p. 261, pl. 7, figs. 1, 2, 1938.
Persea miocenica Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, p. 68, pl. 2, fig. 2, 1937.
Laurus californica Lesquereux, Rept. U. S. Geol. Surv. Terr., vol. 8, p. 252, pl. 57, fig. 3; pl. 58, figs. 6-8, 1883.
Laurus oregoniana Knowlton, U. S. Geol. Surv. Bull. 204, p. 58, pl. 9, fig. 2, 1902 (not fig. 3, which is Lindera oregoniana [Knowlton] Chaney and Axelrod).
Magnolia californica Lesquereux, Mem. Harvard Mus. Comp. Zoöl., vol. 6, no. 2, p. 25, pl. 6, fig. 5 only, 1878.
  Condit, Carnegie Inst. Wash. Pub. 476, p. 260 (part), 1938.
  Condit, Carnegie Inst. Wash. Pub. 553, p. 78, pl. 16, fig. 4, 1944.

Euonymus ? montana MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 60, pl. 11, fig. 7, 1933.
Prunus masoni LaMotte, Carnegie Inst. Wash. Pub. 455, p. 131, pl. 10, figs. 1, 2, 5, 1936.

Our specimens are clearly the same as some of those first described from the Neroly of California at Corral Hollow by Lesquereux many years ago, and later by Condit from the same flora. Leaves of this sort were originally placed in the genus Laurus, and several species were designated by Lesquereux. One of these, Laurus grandis (Lesquereux, 1883, pl. 58, figs. 1, 3), shows numerous small secondaries diverging at nearly right angles proximad; Sanborn has pointed out that this is a typical feature of certain species of Phoebe (1947, p. 19). A second species, L. californica, has broader leaves than the rest, but its shape together with its nervation as figured is very similar to that of our smaller specimens as shown on plate 34, figures 1 and 3. Two other species assigned by Lesquereux to Laurus are now considered to represent other genera. The small, slender leaves described as L. salicifolia were not regarded by Condit (1938, p. 261) as distinct from the other Neroly specimens described by Lesquereux, but Axelrod (1939, p. 102) has subsequently shown that they represent Umbellularia. The leaf of L. princeps Heer suggested to Lesquereux an identity with the leaves described by Heer from Oeningen. There are, however, marked differences in the number of secondaries and in their angle of divergence; as noted on an earlier page, this specimen represents Magnolia. Numerous specimens collected from the Neroly during the past decade show that Persea leaves are well represented in the flora, and fully confirm Condit's generic assignment for some of the species synonymized.

Condit also placed in synonymy under P. princeps leaves figured as P. pseudocarolinensis by Lesquereux in his Auriferous Gravels paper of 1878. The more nearly perfect of these specimens (pl. 7, fig. 1), which is type no. 280 in the University of California collection, is in no way different from our Neroly material; said by Lesquereux to come from Table Mountain (Mio-Pliocene), this specimen shows the matrix of the Chalk Bluffs locality (Middle Eocene). MacGinitie figures additional material from the Chalk Bluffs flora, and notes that P. pseudocarolinensis is one of its most abundant species. Specimens figured by Sanborn from the Comstock flora of Oregon, and by Potbury from the LaPorte of California, show similarity and have been referred to P. pseudocarolinensis. Lauraceous leaves are so generalized that their specific identity may be difficult to establish, and there seems to be no basis for distinguishing the Eocene from the Miocene leaves of the Neroly flora. However, the use of Schimper's name, princeps, for the North American material (Condit, 1938, p. 261) is open to question, particularly since there are no illustrations for comparison with our specimens. It therefore seems preferable to follow MacGinitie in using the name which Lesquereux applied to his earliest citation, P. pseudocarolinensis. We shall not raise the question here whether there is a sound basis for distinguishing the smaller and more slender leaves now assigned to P. coalingensis (Dorf) Axelrod, from the Pliocene of California, from P. pseudocarolinensis. Similarly, the leaves of P. lanceolata (Berry) Brown from the Latah flora are related, but likewise seem to be more slender than P. pseudocarolinensis.

The synonymy presented above includes a number of specimens which have not previously been grouped under P. pseudocarolinensis, and they now require comment. The types of P. pseudocarolinensis come from two localities, Chalk Bluffs (Lesquereux, 1878, pl. 7, fig. 1) and Table Mountain (ibid., pl. 7, fig. 2). We agree with MacGinitie (1941, p. 119) and Lesquereux that they are properly referable to Persea. Condit, however (1944a, p. 47), was inclined to regard the Chalk Bluffs specimen (pl. 7, fig. 1) as Magnolia californica Lesquereux. The type of M. californica from Chalk Bluffs (Lesquereux, 1878, pl. 7, fig. 7) apparently represents Pongamia ovata MacGinitie (MacGinitie, 1941, p. 132). The specimen of M. californica from Table Mountain (Lesquereux, 1878, pl. 6, fig. 5) cannot be separated from the type of Persea pseudocarolinensis from the same locality (ibid., pl. 7, fig. 2). Furthermore, it differs from the leaves of M. grandiflora Linnaeus, with which Condit compared it, having less numerous secondaries which are broadly looping rather than relatively straight. Since we find no basis for separating the Table Mountain specimens of P. pseudocarolinensis from those identified by Lesquereux and Condit as M. californica, and since both of them are well matched by avocado leaves, the Table Mountain specimens of M. californica are transferred to P. pseudocarolinensis.

In his study of the San Pablo (Neroly) flora, Condit (1938) also recognized leaves of Magnolia. Of the two specimens of M. californica Lesquereux, we find that the one from Loma Ranch (no. 1253) represents P. pseudocarolinensis on the basis of its widely spaced, arching secondaries. But the one from Corral Hollow (no. 1254) is correctly assigned as to genus, and, with the Corral Hollow specimen (U. C. Mus. Paleobot. no. 1927) figured by Lesquereux (1883, pl. 58, fig. 2) as Laurus princeps Heer, closely resembles leaves of the living M. grandiflora Linnaeus in venation and heavy texture. Since the types of M. californica have been assigned to Persea and Pongamia, as noted above, a new name is required for these Corral Hollow specimens; on a preceding page they have been named Magnolia corrallina Chaney and Axelrod.

The leaves described as Prunus masoni LaMotte from the Upper Cedarville flora differ from those of P. integrifolia Sargent, with which they were compared, in lacking the prominent intersecondaries that typify leaves of the insular cherry; there also are important differences in shape, as well as in details of secondary venation. All the leaves of P. masoni LaMotte, including the "abnormal" ones reported by LaMotte (1936, p. 132), are within the range of variation of modern leaves of Persea. The Trout Creek specimens of Euonymus ? montana MacGinitie and Persea miocenica Arnold represent the same species, and both can be matched by leaves of P. pseudocarolinensis in our large suite of material.

Two of the Mascall specimens, one of which is illustrated on plate 34 as figure 4, broadly resemble the leaves of Asimina triloba (Linnaeus) Dunal in general outline and in grosser aspects of venation. There are, however, several important differences which indicate that these leaves are not Asimina. The Mascall leaves have widely spaced, looping secondaries as compared with the nearly subparallel and more closely spaced secondaries of Asimina. In addition, the lowest secondary loops well upward along the margin in the fossil, whereas Asimina has a relatively short basal secondary. In the fossil leaves the secondaries do not bifurcate distad as commonly as in Asimina, and there is a subtle difference in the trend of the tertiaries. The Mascall material also includes specimens simulating an entire-margined sassafras type of leaf, as shown by figure 3 on plate 34. Such leaves may be distinguished from those of Sassafras by the fact that in Persea the first secondary above the lowest pair loops evenly upward at a moderate angle to join the secondary above, whereas in Sassafras it regularly diverges at a higher angle and tends to arch downward to meet the secondary below; also the leaves of Persea have a much heavier texture.

The leaves of Persea pseudocarolinensis were originally likened to those produced by the living P. carolinensis Nees, which is now known as P. borbonia (Linnaeus) Sprengl, and relationship is also apparent with the leaves of P. pubescens (Pursh) Sargent. These trees are found along the Atlantic Coastal Plain from Virginia southward into the Gulf states, with P. borbonia ranging into eastern Texas and adjacent Arkansas. They regularly frequent swamps and stream borders in association with numerous species which have close relatives in the Mascall flora, as discussed in detail in the chapter on paleoecology.

Finally, leaves of Persea americana Miller are much like our larger fossil specimens, and leaves of the variety drymifolia of this living species closely resemble some of our smaller obovate specimens. Some of the Neroly specimens collected in recent years can only be matched in size by the leaves of P. americana. A possible difference is the longer petioles of the living species of Persea, but since only one of our fossil leaves shows a complete petiole, we have no basis for knowing whether this is a significant distinction; at least two of the specimens figured by MacGinitie from Chalk Bluffs have short petioles. When additional fossil and modern material becomes available for study, it may be possible to show that two species of avocado are represented in the Neroly flora.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P4123, P4129, P3735), hypotypes nos. O.S. 868, 3118-3121 incl. Upper Cedarville, Cal.-Nev.: U. C. M. P. (locs. P115, P97), hypotypes nos. 868-871 incl. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), hypotype no. 603. Succor Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P3745).

### Sassafras columbiana new name

(Plate 34, figure 2)

Sassafras hesperia Berry. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 174, pl. 53, figs. 7, 9, 1937.
Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, p. 85, pl. 2, fig. 3, 1937.
Philadelphus bendirei (Knowlton) Chaney. Oliver, Carnegie Inst. Wash. Pub. 455, p. 21, 1934.
Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, p. 88, pl. 3, fig. 4, 1937.
Prunus masoni LaMotte, Carnegie Inst. Wash. Pub. 455, p. 131 (part), (not figs. 1, 2, 5, which are Persea pseudocarolinensis Lesquereux), 1936.

In a forthcoming paper on the Middle Tertiary floras of northern Washington, Idaho, and Montana, Brown is illustrating leaves of Sassafras which show that Sassafras hesperia from the Republic and other floras of essentially the same age represents a different species from that of the Middle and Upper Miocene floras. One important difference is seen in the lobed leaves, which are essentially roundish in outline, not ovate to obovate as in S. columbiana of the Mascall, Blue Mountains, and Succor Creek floras. Another difference is that the lobes are generally shorter and more abruptly acute than in the Miocene S. columbiana.

Leaves of Sassafras are generally rare in the fossil record, and we have discovered only 5 in the Mascall and 4 in the Blue Mountains flora. Our specimens are similar to leaves of the modern Sassafras officinale Nees and Ebermale of the eastern United States. Affinity with S. tzumu Hemsley of central China is less evident, for that species commonly has larger, trilobate leaves.

The leaf illustrated on plate 34 shows relationship to Lindera, but may readily be distinguished from it because the first secondaries above the basal pair diverge at a high angle and then arch downward to join the pair below; in Lindera the first secondaries above the basal pair loop evenly upward to meet the secondaries above.

Occurrence. Mascall, Ore.: U. C. M. P. (loc. P28), hypotype no. 3124, homeotypes nos. 3122, 3123. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937, P5403), homeotype no. 680. Upper Cedarville, Cal.: U. C. M. P. (loc. P115), homeotype no. 872. Succor Creek, Ore.: U. M. M. P.

## Family SAXIFRAGACEAE

### Hydrangea bendirei (Ward) Knowlton

(Plate 36, figures 7-11)

Hydrangea bendirei (Ward) Knowlton, U. S. Geol. Surv. Bull. 204, p. 60, pl. 9, figs. 6, 7, 1902.
Porana bendirei (Ward) Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 16, pl. 8, fig. 4, 1888.
Celastrus sp. Dorf, Carnegie Inst. Wash. Pub. 476, p. 120, pl. 3, fig. 7, 1936.

Hydrangea is a common member of the Mascall flora, being represented by numerous leaves and flowers. Its Blue Mountains record is confined to a single flower, and it is represented at Stinking Water by a single incomplete leaf.

In modern affinities Hydrangea bendirei is clearly Asiatic rather than American. The fossil leaves are slender like those of many Asiatic species, whereas American hydrangeas have large, oval leaves. Such Chinese and Japanese species as H. bretschneideri Dippel, H. aspera Don, H. chinensis Maximowicz, H. umbellata Rehder all resemble our abundant material of H. bendirei.

Hydrangea reticulata MacGinitie from the Weaverville flora of northern California is related to H. bendirei (MacGinitie, 1937), but differs in its oval rather than lanceolate shape. The specimen figured from the Lower Idaho flora as Celastrus sp. (Dorf, 1936) has been carefully checked against the genera Celastrus and Hydrangea, and we believe that in all details of finer nervation it is more nearly representative of the latter genus; it is sufficiently like our Mascall material to be included in H. bendirei.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735, P4123, P4129), hypotypes nos. O.S. 854, 3140-3144 incl. Blue Mountains, Ore: U. C. M. P. (loc. P3936), homeotype no. 3145. Stinking Water, Ore.: U. C. M. P. (loc. P4006), homeotype no. 3146. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), homeotype no. 599. Lower Idaho, Ida.: U. C. M. P. (loc. P635), hypotype no. 1220. Succor Creek, Ore.: U. M. M. P.

### Hydrangea knowltoni (Berry) new combination

Euonymus knowltoni Berry, U. S. Geol. Surv. Prof. Paper 154, p. 255, pl. 56, fig. 9, 1929.
Berry, U. S. Geol. Surv. Prof. Paper 170, p. 34, 1931.
Berry, U. S. Geol. Surv. Prof. Paper 185, p. 117, 1934.
Hydrangea bendirei (Ward) Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 42, pl. 24, fig. 6, 1926.
Berry, U. S. Geol. Surv. Prof. Paper 154, p. 251, pl. 52, fig. 7, 1929.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 176, pl. 53, figs. 1, 2, 1937.
Ternstroemites idahoensis (Knowlton) Berry, U. S. Geol. Surv. Prof. Paper 154, p. 258, pl. 58, fig. 1, 1929.
Gordonia hesperia Berry. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 183, pl. 52, figs. 7, 8 (not figs. 5, 6, which are Gordonia idahoensis [Knowlton] Berry), 1937.

This Latah Hydrangea differs from the Mascall Hydrangea bendirei (Ward) Knowlton in having consistently larger leaves and flowers. Both species find their nearest relationships with modern Asiatic members of the genus. The Latah material compares well with leaves and flowers of H. strigosa Rehder, which is commonly found in thickets in western Hupeh and Szechuan at elevations from 1500 to 3500 feet.

Occurrence. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird locs.)

## Family HAMAMELIDACEAE

### Hamamelis merriami new species

(Plate 35, figures 1-3)

A fine leaf impression and its counterpart in the Mascall flora are considered to be Hamamelis. Two leaves in the Oligocene collections from the John Day Basin, one from Gray's Ranch and the other from Cove Creek, represent the same species, and we are using all three as a basis for the following description.

Description. Leaves ovate to obovate; base rounded to broadly acute; tip subacute to obtuse; largest leaf 9 cm. long and 5.7 cm. wide, smallest leaf 6 cm. long (approx.) and 4.8 cm. wide; petiole stout, 2-3 mm. preserved; midrib firm to heavy, tapering above, straight; 5 to 6 strong alternate secondaries, diverging at moderate angles, the basal pair relatively straight giving the leaf a pseudo-plinerved appearance, the others straight below then broadly looping above, somewhat irregular and wavering in outward course, with prominent abaxial tertiaries supplying marginal area; coarse tertiary pattern forming large polygons enclosing a finer mesh; margin coarsely crenate-sinuate; texture firm to heavy.

Discussion. The leaves of the related genera Hamemelis and Fothergilla are generally similar. On the basis of extended herbarium and field studies of leaves of these genera we believe that they can readily be distinguished. Leaves of Hamamelis are regularly toothed to the basal part of the blade, whereas those of

Fothergilla are typically entire in the lower half of the blade. Since the leaves of *Hamamelis merriami* are crenate-sinuate into the lower part of the blade, we believe that they are correctly assigned as to genus. The leaves of *H. merriami* are easily duplicated by those of the living *H. virginiana* Linnaeus. Certain herbarium specimens (U. C. Herbarium sheets 67712, 589211, 562879) include all the variation shown by the fossils, ranging from ovate to obovate in outline on the same twig. Witch hazel is a large shrub or small tree which ranges widely in eastern North America, from Quebec and New Brunswick westward to central Michigan and Wisconsin, and southward into eastern Texas and central Georgia. Relationship is also apparent with the living *H. japonica* Siebold and Zuccarini, which occurs in Japan in forests related to those in eastern North America.

Hamamelis is rare in the fossil record; it hardly seems likely that its characteristic leaves have been overlooked, for they are readily identifiable. Several species of the form genus Hamamelites have been described from the Upper Cretaceous and Paleocene of North America, but none of them is close to *H. merriami*, and most suggest only a distant relationship to Hamamelis or Fothergilla. From the Middle Eocene of central California MacGinitie (1941) has recorded *Hamamelites voyana* (Lesquereux) MacGinitie; this species differs in having a more irregular tertiary venation than our fossils, or than the modern species of Hamamelis and Fothergilla. *Hamamelis clarus* Hollick from the early Tertiary of the upper Yukon region is suggestive of the genus (Hollick, 1936), but in the strong percurrence of the tertiaries and in marginal characters it seems more nearly representative of Viburnum.

Leaves of *Quercus platania* Heer from Cape Lyell (Heer, 1876, vol. 4, pl. 16, fig. 1) and Alaska (Hollick, 1936, pl. 44, figs. 5, 6), on the other hand, may well represent Hamamelis. They differ from leaves of the modern species only in their slightly greater size and somewhat sharper marginal teeth, characters which are probably not of great significance in view of the Early Tertiary age of these fossils. The only other American Tertiary record of Hamamelis consists of wood from the Upper Miocene of Nebraska (Chaney and Elias, 1936, p. 10).

From the Upper Miocene Shangwang flora of northern China, Hu and Chaney (1938) have recently described *Hamamelis miomollis*. It differs from *H. merriami* in its suborbicular outline and cordate base. In the related genus Fothergilla, Hu and Chaney (1938) have described *Fothergilla viburnifolia*. One of the specimens (pl. 21, fig. 3) has the shape of *H. merriami*, but the basal secondaries are more strongly developed; the other leaves have acuminate apices and a more slender shape.

We take pleasure in naming this species after John Campbell Merriam, who maintained a great interest in the John Day Basin until the end of his life, and who added much to our understanding of the history of life there and elsewhere.

*Occurrence*. Mascall, Ore.: U. C. M. P. (loc. P3735), holotype no. 3126. Lower John Day, Ore.: U. C. M. P. (locs. P125, P3745), paratypes nos. 3127 (Gray's Ranch), 3128 (Cove Creek).

### *Liquidambar pachyphyllum* Knowlton

(Plate 35, figures 4, 5)

*Liquidambar pachyphyllum* Knowlton, U. S. Geol. Surv. Bull. 204, p. 63, pl. 9, fig. 1, 1902.
Chaney, Contr. Walker Mus., vol. 2, p. 174, pl. 15, figs. 2, 3, 1920.
Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 42, pl. 22, fig. 7; pl. 29, fig. 1, 1926.
Condit, Carnegie Inst. Wash. Pub. 553, p. 48, pl. 10, fig. 1, 1944.
Chaney, Carnegie Inst. Wash. Pub. 553, p. 347, 1944.
*Liquidambar europaeum* Al. Braun. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 14, 1888.
Newberry, U. S. Geol. Surv. Monog. 35, p. 100, pl. 47, figs. 1-3, 1898.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 62, 1902.
Chaney, Contr. Walker Mus., vol. 2, p. 174, 1920.
*Liquidambar californicum* Lesquereux. Chaney, ibid., p. 174, 1920.
Berry, U. S. Geol. Surv. Prof. Paper 154, p. 250, 1929.
Berry, U. S. Geol. Surv. Prof. Paper 185, p. 113, 1934.
Oliver, Carnegie Inst. Wash. Pub. 455, p. 21, 1934.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 176, pl. 61, figs. 9, 10, 1937.
Berry, Bull. Torrey Bot. Club, vol. 65, p. 96, fig. 3, 1938.
*Liquidambar protensum* Unger. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 13, pl. 8, fig. 3, 1888.
*Liquidambar europaeum patulum* Knowlton, U. S. Geol. Surv. Bull. 204, p. 62, pl. 10, fig. 5, 1902.
*Liquidambar* sp. ? Knowlton, ibid., p. 63, pl. 12, fig. 4, 1902.
*Liquidambar acutilobum* Chaney, Contr. Walker Mus., vol. 2, p. 175, pl. 15, fig. 4, 1920.
*Liquidambar* fruit Berry, U. S. Geol. Surv. Prof. Paper 170, p. 38, 1931.
Berry, U. S. Geol. Surv. Prof. Paper 185, p. 114, 1934.

A number of leaf impressions represent this species in the Mascall collections, but it is rare at Blue Mountains and is unknown from the Stinking Water flora. *Liquidambar pachyphyllum* is known from several Middle Tertiary floras in the western United States, including the Bridge Creek, Eagle Creek, Molalla, Latah, Mascall, and Blue Mountains floras of Oregon and Washington. It occurs also in the Remington Hill flora of the central Sierra Nevada (Condit, 1944a), and in the Troutdale flora of Oregon and the Lower Ellensburg of central Washington (Chaney, 1944c).

Liquidambar pachyphyllum has been confused by several authors with L. californicum Lesquereux from the Early Tertiary of California. MacGinitie (1941) has pointed out that the older Tertiary species is distinct, being readily separable from L. pachyphyllum by reason of its short, acute lobes separated by wide and shallow sinuses; there is no evidence of intergradation in leaf form between the two species. As we interpret it, L. californicum is now known only from two fossil floras in the western United States, the LaPorte (Potbury, 1935) and Chalk Bluffs (Lesquereux, 1878a; MacGinitie, 1941). Thus all references to L. californicum in Upper Oligocene and Miocene floras are in error, and we herewith transfer them to L. pachyphyllum Knowlton, together with several other species, as indicated in the synonymy above.

The Mascall leaf figured on plate 35 is similar to Liquidambar miosinica Hu and Chaney (1938, pl. 23, figs. 2, 3), a 3-lobed species showing relationship to L. formosana Hance, which ranges from western to southern China and occurs also in Formosa. We have both 3- and 5-lobed leaves in our Mascall collection, but do not think it now advisable to recognize a new species, for our leaves are equally matched by the 3- and 5-lobed leaves of L. styraciflua Linnaeus of the eastern United States. It may be possible to recognize a second Miocene species when more material becomes available. It should be noted, however, that in the nature of the lobes and venation, this Mascall leaf and the Shangwang L. miosinica seem more nearly related to one another than to any living species.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735, P4123, P4129), hypotype no. 3129, homeotypes nos. 3130, 3131, 3132. Blue Mountains, Ore.: U. C. M. P. (locs. P3936, P3937), hypotype no. 682. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird locs.).

## Family PLATANACEAE

### Platanus dissecta Lesquereux

(Plate 36, figure 3)

Platanus dissecta Lesquereux, Mem. Harvard Mus. Comp. Zoöl., vol. 6, no. 2, p. 13, pl. 7, fig. 12; pl. 10, figs. 4, 5, 1878.
Oliver, Carnegie Inst. Wash. Pub. 455, p. 22, pl. 3, fig. 3, 1934.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 174, pl. 52, figs. 1-3, 1937 (see synonymy).
Acer bendirei Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 14, pl. 5, fig. 5; pl. 6, fig. 1; pl. 7, fig. 1, 1888.
Acer merriami Knowlton, U. S. Geol. Surv. Bull. 204, p. 74, pl. 14, fig. 7, 1902.
Acer trilobatum productum Heer. Lesquereux, Rept. U. S. Geol. Surv. Terr., vol. 8, p. 253, pl. 59, figs. 1-4, 1883.
Magnolia ingelfieldi Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 13, 1888.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 59, 1902.
Platanus aceroides (Goeppert) Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 19, pl. 5, fig. 7, 1888.
Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, p. 88, pl. 3, fig. 1, 1937.
Platanus aceroides ? (Goeppert) Heer. Knowlton, U. S. Geol. Surv. Bull. 204, p. 65, 1902.
Platanus aspera Newberry. Berry, U. S. Geol. Surv. Prof. Paper 170, p. 34, 1931.
Platanus nobilis Newberry. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 19, 1888.
Platanus nobilis ? Newberry. Knowlton, U. S. Geol. Surv. Bull. 204, p. 65, 1902.
Platanus raynoldsii Newberry. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 19, 1888.
Platanus sp. Knowlton, U. S. Geol. Surv. Bull. 204, p. 66, 1902.
Quercus cognatus Knowlton. Brooks, Ann. Carnegie Mus., vol. 24, p. 292, pl. 16, fig. 2, 1935.
Quercus mccanni Berry. Dorf, Carnegie Inst. Wash. Pub. 476, p. 114 (part), 1936.
Sassafras hesperia Berry. Brooks, Ann. Carnegie Mus., vol. 24, p. 299, pl. 20, fig. 1, 1935.

Sycamore leaves are abundant in the Mascall but are less common in the Blue Mountains and Stinking Water floras. Platanus dissecta is one of the characteristic Miocene species in floras of the Columbia Plateau and northern Great Basin. It has recently been discovered in the Early Pliocene Dalles and Ellensburg floras of this region (Chaney, 1944b, 1944c), but its occurrence seems to have been more restricted in the Pliocene than in the Miocene.

It seems probable that two of the specimens from Van Horn's Ranch may be more nearly related to Platanus aceroides Goeppert than to P. dissecta Lesquereux. These leaves, like those of P. aceroides, are characterized by having a greater width than length, though the range of variation of P. aceroides also includes specimens of essentially equal dimensions. In these features, as well as in the character of the marginal teeth, the European P. aceroides is closely allied to P. occidentalis Linnaeus of the eastern United States. Another feature which suggests that we may have a second species of sycamore in the flora is that in our abundant material we find no leaves of intermediate character. All our specimens of P. dissecta have a much greater length than width and seem more nearly related to P. racemosa Nuttall of central and southern California and to *P. orientalis* Linnaeus of Eurasia. However, we have noted leaves of *P. occidentalis* which have these dimensions, and it is apparent that all three of these living species are closely related to one another, and to *P. dissecta*.

*Occurrence.* Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735, P4123, P4129), hypotypes nos. O.S. 850, O.S. 869, O.S. 1797, O.S. 1797a, O.S. 1797b, 3133, homeotypes nos. 3134, 3135, 3136. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotype no. 683, homeotypes nos. 684, 686, 3137. Stinking Water, Ore.: U. C. M. P. (loc. P4120), homeotypes nos. 3138, 3139. Upper Cedarville, Cal.-Nev.: U. C. M. P. (locs. P97, P115), homeotypes nos. 843-848 incl. Lower Idaho, Ida.: U. S. N. M.; U. C. M. P. (locs. P635, P637, P638), homeotypes nos. 1205, 1206, 1207. Succor Creek, Ore.: U. S. N. M.; U. M. M. P.; U. C. M. P. (locs. P3742, P3745, P3746, P3747). Latah, Wash.-Ida.: U. S. N. M. (Whitebird, Grand Coulee, Spokane locs.).

## Family ROSACEAE

### *Amelanchier couleeana* (Berry) Brown

(Plate 36, figure 1)

*Amelanchier couleeana* (Berry) Brown, Jour. Wash. Acad. Sci., vol. 36, p. 349, 1946 (see synonymy and discussion).
*Amelanchier dignatus* (Knowlton) Brown. Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 23, p. 228, 1938.
*Betula bendirei* Knowlton. Smith, Bull. Torrey Bot. Club, vol. 65, p. 558, pl. 29, fig. 3, 1938.
*Phyllites cladastrifolia* Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, no. 8, p. 101, pl. 8, fig. 2, 1937.

An incomplete leaf in our Mascall collection is identified as *Amelanchier couleeana*, and it constitutes the sole record of this species in the flora as now known. The specimen is not so large as the type of the species, nor has it the dimensions of *A. magnifolia* Arnold (1937); it is but slightly smaller than the specimen figured by Brown from the Latah (1937a, pl. 53, fig. 11). The specimen figured on our plate 36 is from the Lower Idaho flora.

The Miocene *Amelanchier couleeana* differs from *A. alvordensis* Axelrod from the Pliocene of this region in being consistently larger (Axelrod, 1944f). This is interpreted as a reflection of the more humid climate that characterized this area in the Miocene when the Cascade Range at the west was lower than later in the Tertiary. *Amelanchier alvordensis* survived under the drier and cooler climate of the Pliocene. The Miocene and Pliocene species both resemble leaves of the living *A. alnifolia* Nuttall. Whereas the large leaves of *A. couleeana* resemble those which *A. alnifolia* regularly produces in the more humid parts of its range on the Pacific slope, *A. alvordensis* is more like the smaller and thicker-textured leaves of *A. alnifolia* in the drier and cooler parts of its range.

*Occurrence.* Mascall, Ore.: U. C. M. P. (loc. P3735), homeotype no. 5121. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), homeotypes nos. 596, 597, 598. Lower Idaho, Ida.: U. C. M. P. (loc. P635), hypotype no. 2991. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600). Latah, Wash.: U. S. N. M. (Grand Coulee, Spokane locs.). Succor Creek, Ore.: U. M. M. P.

### *Amelanchier coveus* (Chaney) new combination

(Plate 36, figure 2)

*Prunus coveus* Chaney, Carnegie Inst. Wash. Pub. 346, pl. 15, figs. 4, 6 (not figs. 1, 2, which are *Prunus chaneyi* Condit, or fig. 3, which is *Rosa hillae* Lesquereux), 1927.
*Amelanchier subserrata* Smith, Amer. Mid. Naturalist, vol. 25, p. 514, pl. 13, fig. 1, 1941.
*Prunus covea* Chaney. Smith, ibid., p. 516, pl. 13, fig. 10, 1941.
*Rhamnus* sp. Smith, ibid., p. 518, pl. 11, fig. 3, 1941.

The specimens cited above are all characterized by a percurrent tertiary venation trending at right angles to the axis of the leaf blade, fine, sharp marginal teeth, and secondaries that diverge upward in large loops. They are similar to leaves of the living eastern species, *Amelanchier spicata* (Linnaeus) C. Koch (U. C. Herbarium sheet 552865).

*Prunus coveus* Chaney was compared originally with leaves of *P. emarginata* (Douglas) Walpers of the western United States. All the specimens cited above differ from leaves of bitter cherry in having a characteristic cross-percurrent tertiary venation, not the irregular tertiaries of *P. emarginata*. Two of the leaves originally included in *P. coveus* represent other species: figure 1 is now interpreted as *P. chaneyi* Condit, and figure 3 is a leaflet of *Rosa hilliae* Lesquereux. The fruit (fig. 2) probably is to be associated with the leaf now identified as *P. chaneyi* Condit.

The record of *Amelanchier coveus* in the Mascall flora is limited to the basal part of a leaf that is indistinguishable from the type material and from the Thorn Creek fossils. The Thorn Creek material includes leaves the size of the type specimen from Cove Creek, and in the latter flora there is a leaf the size of the smaller specimens from the Thorn Creek and Mascall floras. As we can find no basis for separating the Upper Oligocene and Miocene leaves, we are grouping all the material into one species.

*Occurrence.* Bridge Creek, Ore.: U. C. M. P. (locs. P3939, P125), holotype no. 89, paratype no 87.

Mascall, Ore.: U. C. M. P. (loc. P3735), hypotype no. 2992. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600), homeotypes nos 3261, 3262, 3263.

### *Crataegus gracilens* MacGinitie

(Plate 36, figure 6; plate 37, figures 1, 2)

*Crataegus gracilens* MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 57, pl. 11, fig. 1, 1933.
*Betula* sp. Oliver, Carnegie Inst. Wash. Pub. 455, p. 18 (part) (not pl. 3, fig. 5, which is *Betula fairii* Knowlton), 1934.
*Corylus macquarrii* (Forbes) Heer. Oliver, Carnegie Inst. Wash. Pub. 455, p. 23 (part), 1934.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 171, pl. 50, fig. 6, 1937.

Ten leaves in the Blue Mountains flora and two in the Mascall represent a fine species of Crataegus. We had provisionally considered this material to represent a different species from the Trout Creek *Crataegus gracilens* MacGinitie. It seemed to differ in having no marginal lobes or only weakly developed ones, and a broadly truncate to subcordate rather than a subcuneate base. We have examined the large collections of the Trout Creek flora at the University of Michigan and find there additional specimens of *C. gracilens* MacGinitie which show that its range of variation includes large, oval leaves with broadly truncate bases and with margins that may be essentially without lobes. We therefore identify the Mascall species as *C. gracilens* MacGinitie.

An exact comparison of *Crataegus gracilens* with any one modern member of the genus is not an easy task. This is because Crataegus is a "plastic" genus, containing numerous "species" founded on rather inconsequential characters. It is nonetheless apparent that our fossil leaves are matched by several species of haw in the eastern United States, of which *C. boyntonii* Beadle shows great similarity. Of the Asiatic species, *C. hupehensis* Sargent is also similar.

A number of fossil species of Crataegus have been described from the western Tertiary, but most of them are quite different from *Crataegus gracilens*. From the Early Tertiary of Alaska, however, such fossils as *Corylus americana fossilis* Newberry (Hollick, 1936, pl. 48, fig. 2) and *Crataegus cappsii* Hollick (ibid., pl. 71, fig. 3) show relationship to *C. gracilens*, and may well be ancestral to this species. Likewise, the leaves figured by Berry (1926b, pl. 17, fig. 1; pl. 18, figs. 2-4; pl. 19, fig. 5) as *Corylus macquarrii* (Forbes) Heer from British Columbia seem to differ in no fundamental way from *C. gracilens* MacGinitie.

*Occurrence*. Mascall, Ore.: U. C. M. P. (loc. P3735), hypotype no. 2993. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotypes nos. 2994, 2995, homeotypes nos. 667, 670, 2296, 2297. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), holotype no. 594, paratype no. 595. Succor Creek, Ore.: U. S. N. M.; U. M. M. P.

### *Crataegus pacifica* Chaney

*Crataegus pacifica* Chaney, Contr. Walker Mus., vol. 2, p. 176, pl. 17, fig. 1, 1920.
*Crataegus newberryi* Cockerell. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 131, 1936.
Condit, Carnegie Inst. Wash. Pub. 553, p. 49, pl. 11, figs. 1-3, 1944.
Condit, Carnegie Inst. Wash. Pub. 553, p. 82, pl. 16, fig. 1, 1944.

The specimens of Crataegus from the Eagle Creek, Upper Cedarville, Remington Hill, and Table Mountain floras are sufficiently alike to be grouped into one species. They represent a different plant from *Crataegus newberryi* Cockerell from the Upper Oligocene Bridge Creek and Gray's Ranch floras, being smaller, with fewer marginal lobes which are generally directed forward at lower angles, and an acute to strongly cuneate rather than acute to rounded base. Another important difference is that in leaves with two or more lateral lobes the lowest ones are the largest, whereas in *C. newberryi* they are of more nearly equal length throughout.

*Crataegus pacifica* Chaney finds relationship with *C. cuneata* Siebold and Zuccarini, a bushy tree of central and northern China and southern Japan. Two other species that have leaves much like these fossils are *C. monogyna* Jacquin and *C. oxycantha* Linnaeus of Europe.

The types of *Crataegus newberryi* Cockerell have been compared to the modern *C. pinnatifida* Bunge, but here reservations must be made with respect to the shape of the lobes, which are more rounded in the fossil than in the modern species, as noted earlier by Chaney (1927, p. 122). In this respect the specimens of *C. microcarpifolia* Arnold from Trout Creek (Arnold, 1937) and Thorn Creek (Smith, 1941) seem closer to *C. pinnatifida* than does the Bridge Creek material of *C. newberryi*.

*Occurrence*. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), homeotypes nos. 853, 854. Remington Hill, Cal.: U. C. M. P. (loc. P3935), hypotypes nos. 2420, 2421, 2422. Table Mountain, Cal.: U. C. M. P. (loc. P3715), hypotype no. 2754.

### *Holodiscus harneyensis* (Arnold) Axelrod

*Holodiscus harneyensis* (Arnold) Axelrod, Carnegie Inst. Wash. Pub. 590, p. 65, pl. 4, fig. 3, 1950.
*Cercocarpus harneyensis* Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, p. 90, pl. 4, fig. 3, 1937.

Leaves of this species differ from those of Cercocarpus in having a thin to medium rather than heavy coriaceous texture, rounded to subacute rather than acute marginal teeth, and wide sinuses, rarely seen in mountain mahogany. Examination of the large Trout Creek collections at the University of Michigan shows that there are several additional leaves of this species in the flora. Some have one or two serrations on the main marginal teeth, and all are of medium thin texture. We find that these leaves are much like those of the modern Holodiscus discolor (Pursh) Maximowicz, which ranges from British Columbia southward through California and southeastward into the Rocky Mountains.

The same species occurs in the Upper Pliocene Sonoma flora north of San Francisco Bay (Axelrod, 1950), and in the Upper Pliocene Santa Clara flora south of Palo Alto. A related species in the Miocene of southern California is H. elliptica Axelrod (1939), which lived under a semiarid climate with Madro-Tertiary species.

Occurrence. Trout Creek, Ore.: U. M. M. P.

### Holodiscus idahoensis new name

Cercocarpus cuneatus Dorf. Smith, Amer. Mid. Naturalist, vol. 25, p. 514, pl. 12, fig. 1, 1941.
Phyllites sp. Knowlton, U. S. Geol. Surv. Prof. Paper 131, p. 191, pl. 43, figs. 13, 15, 1923.

Examination of the Thorn Creek specimen shows that it differs from leaves of Cercocarpus in having a thinner texture and rounded rather than sharply acute teeth. The leaves figured by Knowlton as Phyllites sp. from Creede are indistinguishable from the Thorn Creek species. We find all these specimens to be similar to leaves of the modern Holodiscus dumosus (Nuttall) Heller, a widely distributed shrub of the western part of the continent.

Occurrence. Thorn Creek, Ida.: U. M. M. P. Creede, Colo.: U. S. N. M.; U. C. M. P. (loc. P379).

### Prunus chaneyi Condit

(Plate 36, figure 4)

Prunus chaneyi Condit, Carnegie Inst. Wash. Pub. 476, p. 263, pl. 5, figs. 4, 5, 1938.
Prunus coveus Chaney, Carnegie Inst. Wash. Pub. 346, p. 123, pl. 15, figs. 1, 2 (not fig. 3, which is Rosa hilliae Lesquereux), 1927.
Oliver, Carnegie Inst. Wash. Pub. 455, p. 23, 1934.
Prunus rustii Knowlton. Dorf, Carnegie Inst. Wash. Pub. 476, p. 118, pl. 2, fig. 6, 1936.

The record of Prunus in the Blue Mountains flora is limited to the material reported earlier by Oliver. Only one of the two specimens she records is in our collections, and it displays all the characteristic features of Prunus. Its closest affinity is with the modern Prunus demissa (Nuttall) Walpers – P. virginiana Linnaeus phylad of central North America. Prunus chaneyi was originally thought by Condit to be closely related to P. serotina Ehrhart of the eastern United States, but Axelrod (1944b, p. 258) has given reasons for considering it to be closer to P. demissa and its relatives.

Prunus is not a commonly recorded genus in the western Tertiary. The known record of Prunus chaneyi is limited to four floras, the Neroly of west-central California (Condit, 1938), the Lower Idaho of southwestern Idaho (Dorf, 1936), the Lower John Day of Oregon (Chaney, 1927), and the Blue Mountains of eastern Oregon. A Thorn Creek record (Smith, 1941, p. 516) is open to question because the specimen is not present in the collections. Three species of Prunus have been recorded from the Pliocene of Oregon, but none of these is like P. chaneyi. Prunus harneyana Axelrod from Alvord Creek (Axelrod, 1944f) resembles P. serotina of eastern North America, whereas P. treasheri Chaney from the Troutdale (Chaney, 1944c) is like the Asiatic P. davidiana (Carrière) Franchet. As shown below under P. moragensis Axelrod, the two leaves assigned to P. irvingi Chaney from the Deschutes flora (Chaney, 1938b) seem to represent Populus and Salix rather than Prunus.

Occurrence. Blue Mountains, Ore.: U. C. M. P. (loc. P3936), hypotype no. 691. Lower Idaho, Ida.: U. C. M. P. (locs. P635, P638), hypotype no. 1214, homeotype no. 1215.

### Prunus moragensis Axelrod

(Plate 36, figure 5)

Prunus moragensis Axelrod, Carnegie Inst. Wash. Pub. 553, p. 140, pl. 30, figs. 6, 8, 10, 1944.

Prunus moragensis, described from the Middle Pliocene Mulholland flora of west-central California, has been reported previously from the Chalk Hills ("Truckee") flora of western Nevada (Axelrod, 1944b, p. 140). Leaves which are indistinguishable from this species have been identified recently in the Trout Creek and Molalla floras; the Trout Creek specimen is illustrated on plate 36. All these leaves are much like those of the modern bitter cherry, Prunus emarginata (Douglas) Walpers, a widely distributed shrub in the western United States.

Two other species of fossil Prunus in western Tertiary floras have been compared with P. emarginata, but none of the specimens appear to be Prunus. Of the two specimens representing P. irvingi Chaney from the Middle Pliocene Deschutes flora of eastern Oregon (Chaney, 1938b, pl. 7, figs. 3, 4), one (fig. 3) is no more than a small leaf of Populus alexanderi Dorf. The other (fig. 4) differs from our material and from leaves of Prunus emarginata in having straighter and heavier secondaries, more prominent intersecondaries, and a thicker texture; it may well be Salix rather than Prunus. Prunus coveus Chaney (1927, pl. 15, figs. 1-4, 6) has also been compared with the living P. emarginata. As stated above under Amelanchier coveus, these specimens are now considered to represent another genus.

Occurrence. Trout Creek, Ore.: U. C. M. P. (loc. P275), hypotype no. 5122.

### Rosa harneyana new species

(Plate 37, figure 4)

Rosa hilliae Lesquereux. MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 57, 1933.
LaMotte, Carnegie Inst. Wash. Pub. 455, p. 132, 1936.
Umbellularia lanceolata Berry. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 127 (part), 1936.

A single leaflet in the Stinking Water flora and leaflets of similar type in the Trout Creek and Upper Cedarville floras are used as a basis for the following description.

Description. Leaflets ovate to elliptic, subacute above and below; length 2.5 to 3.8 cm., averaging about 3.0 cm., width 1.4 to 2.0 cm., mostly averaging about 1.5 cm.; petiolule firm, 2 to 5 mm. long; midrib firm, straight, and tapering above; 6 to 8 thin, wavering secondaries, with intersecondaries, mostly diverging at 30° to 40°, looping upward within the margin, supplying thin and wavering tertiaries to the marginal teeth, joining secondaries above by a wide loop of tertiary caliber; tertiaries irregular and rather prominent; margin serrate; texture medium thin.

Discussion. Rosa is now known in a number of fossil floras in the western United States, including the Florissant, Gray's Ranch, Tehachapi, Alvord Creek, Neroly, and Elko. Rosa hilliae Lesquereux is present in the Florissant, Gray's Ranch, and Neroly floras. Chaney (1927, p. 123) has discussed reasons for considering the Florissant R. scudderi Cockerell and R. wilmattae Cockerell as probably identical with R. hilliae, and MacGinitie (1953, p. 121) concurs in this assignment. Rosa hilliae differs from R. harneyana chiefly in having a rounded rather than a cuneate base. It is realized that specific separation of modern Rosa leaflets is hardly possible, and similarly our species may prove not to be distinct from R. hilliae in the light of more abundant material. Yet there is no reason for assuming that only one species of Rosa occupied stream banks and moist woods in the Miocene. Since the specimens from the Stinking Water, Trout Creek, and Upper Cedarville floras resemble one another more nearly than they do Rosa hilliae, we believe R. harneyana to be a valid species.

The Middle Miocene R. miocenica Axelrod from the Tehachapi flora of southern California (Axelrod, 1939) is considerably smaller than R. harneyana, as is to be expected in view of its semiarid environment. Likewise, the Alvord Creek R. alvordensis Axelrod from the Lower Pliocene of southern Oregon has smaller leaflets than R. harneyana, yet it is similar to this Miocene species in that both show relationship to such living western species as R. pisocarpa Gray, R. californica Charnisso and Schlechtendal, and R. gymnocarpa Nuttall. The Alvord Creek flora also has species of Amelanchier, Populus, and Acer with smaller leaves than those of related Miocene species in the same region. We have designated these younger species as distinct from the Miocene, and believe they reflect the drier climate that developed there in post-Miocene time.

Occurrence. Stinking Water, Ore.: U. C. M. P. (loc. P4120), holotype no. 2998. Trout Creek, Ore.: U. C. M. P. (loc. P275), homeotype no. 638. Upper Cedarville, Cal.-Nev.: U. C. M. P. (locs. P97, P115), homeotypes nos. 855, 5123.

### Spiraea harneyana new species

(Plate 37, figure 3)

Description. Leaf oval, rounded above and gradually tapered below to a subacute base; about 3.4 cm. long and 1.8 cm. wide at middle; petiole firm, 7 mm. long; midrib medium, rather rapidly tapered above; 3 to 4 alternate secondaries diverging from midrib at 20° to 30°, the lower ones looping well upward into the middle and upper part of the blade and within the margin, joining secondaries above by a series of tertiary cross-ties; prominent tertiaries from secondaries supplying marginal teeth, irregular tertiaries enclosing a polygonal mesh marked by veinlets with T ends; margin serrate in upper two-thirds, entire below; texture medium.

Discussion. Two leaves in the Stinking Water flora compose the record of this species. They are similar to those of such modern shrubs as Spiraea densiflora Nuttall (S. helleri Rydberg) and S. idahoensis A. Nelson of the western United States, and to S. corymbosa Rafinesque of the eastern United States. Spiraea is a common member of montane forests in both these regions, where it is found regularly along stream banks and in moister sites.

MacGinitie has recorded Spiraea (?) sp. from Trout Creek (1933). It is Spiraea, but represents a different species from S. harneyana, resembling such western plants as S. menziesii Hooker and S. douglasii Hooker, both common members of the Upper Transition forest in the western United States. Three species have been reported from the Tertiary of Alaska (Hollick, 1936), but relationship with the Mascall species is problematical, as is their generic assignment.

Occurrence. Stinking Water, Ore.: U. C. M. P.

(loc. P4006), holotype no. 3147, homeotype no. 3148.

## Family LEGUMINOSAE

### *Albizzia oregoniana* (Lesquereux) new combination

(Plate 37, figure 11; plate 10, figure 1)

*Acacia oregoniana* Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 14, pl. 5, fig. 4, 1888.

This species is now represented by the nearly perfect impression (and counterpart) of the type, and by parts of 3 other pods in the Mascall collection. The pods closely resemble those produced by living Asiatic species of Albizzia, notably *Albizzia kalkora* (Roxbury) Prain and *A. julibrissin* Durazzini; specimens of the latter species in the U. S. National Herbarium (sheets 1370023 and 1053542) are particularly close matches for the fossil *A. oregoniana*.

We have not yet found any leaflets that might be assigned to *A. oregoniana*. Since the leaflets of the living species are small and relatively heavy, they might readily be lost in transport to a basin of deposition, particularly if the trees lived on more distant slopes. By contrast, the pods might be expected to float for relatively long distances, and hence occasionally to enter the record even though the plants lived in areas somewhat removed from the immediate site of deposition.

*Occurrence*. Mascall, Ore.: U. S. N. M., holotype no. 4212; U. C. M. P. (locs. P3735, P28, P4123), holotype no. 5124, homeotype no. 5125.

### *Amorpha oblongifolia* Axelrod

(Plate 37, figure 10)

*Amorpha oblongifolia* Axelrod, Carnegie Inst. Wash. Pub. 516, p. 111, pl. 9, figs. 2-4, 1939.
Axelrod, Carnegie Inst. Wash. Pub. 590, p. 108, pl. 3, fig. 2, 1950.

A single leaflet in the Hog Creek florule shows all the diagnostic features of Amorpha, and is much like those produced by the living *Amorpha californica* Nuttall. This large shrub ranges from north-central California southward into Baja California, and reappears in southern Arizona. It is found commonly in the subhumid parts of the oak-madrone, pine-fir, and redwood forests, and ranges also into the bordering live oak woodland communities.

The specimen from the Lower Idaho flora has an oblong shape like *A. oblongifolia* Axelrod from the Tehachapi flora. As a result of more extended studies of fossil species of the genus, Axelrod (1956) has recently combined the oval leaflets of *A. condoni* Chaney from the Sonoma, Alvord Creek, Troutdale, and Napa floras with those of *A. oblongifolia*. Specimens from some of these localities include oblong as well as oval leaflets, and all have been compared with the same living species. However, the types of *A. condoni* Chaney from the Dalles flora (Chaney, 1944b) differ in shape from all these other records of Amorpha. They show relationship to the Latah leaflets of *Sophora spokanensis* Knowlton.

*Occurrence*. Lower Idaho, Ida.: U. C. M. P. (loc. P635), hypotype no. 5126.

### *Cercis washoensis* new species

*Cercis spokanensis* Knowlton. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 132, pl. 10, fig. 4, 1936.
*Leguminosites* sp. Dorf. Carnegie Inst. Wash. Pub. 476, p. 119, pl. 3, fig. 1, 1936.

*Description*. Pods ranging from oblong to ovate-lanceolate in shape; tip acuminate to obtuse, with a short prickle; base acute to obtuse; length 3.5 to 3.8 cm.; width 1.1 to 1.4 cm. near middle of pod; marginal sutures well preserved; swellings and dots on pods suggest the presence of several small seeds; surface markings not preserved; pedicel short; texture firm.

*Discussion*. These pods from the Upper Cedarville and Lower Idaho floras resemble those produced by such living species of redbud as *Cercis canadensis* Linnaeus, *C. chinensis* Bunge, and *C. occidentalis* Torrey. It will not be possible to indicate their modern affinity more precisely until more fossil pods are available for study, or until fossil leaves are found in the same beds. *Cercis buchananensis* Condit, a species now known from leaves only, may have produced the pods here named *C. washoensis*.

*Cercis washoensis* differs from *C. spokanensis* Knowlton in its much smaller size, and in details of morphology. Since *C. spokanensis* is not Cercis, it has been relegated to *incertae sedis*. There is a possibility that it may represent the same species as *Sophora spokanensis* Knowlton, whose leaflets are common at the localities where the pods of *C. spokanensis* have been found.

*Occurrence*. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), holotype no. 811. Lower Idaho, Ida.: U. C. M. P. (loc. P635), hypotype no. 1217.

### *Gymnocladus dayana* (Knowlton) new combination

(Plate 37, figures 7-9)

*Salix dayana* Knowlton, U. S. Geol. Surv. Bull. 204, p. 31, pl. 2, fig. 10 (not fig. 9, which is *Quercus dayana* Knowlton), 1902.

Gymnocladus casei Berry, Proc. U. S. Nat. Mus., vol. 54, p. 631, pl. 94, fig. 2, 1918.
Chaney and Elias, Carnegie Inst. Wash. Pub. 476, p. 42, pl. 6, fig. 7, 1936.
Meibomites cf. M. lucens Knowlton. Brooks, Ann. Carnegie Mus., vol. 24, p. 296, pl. 19, figs. 1-3, 1935.
Betula heteromorpha Knowlton. Brooks, Ann. Carnegie Mus., vol. 24, p. 283, pl. 5, fig. 1 only, 1935.
Acer negundoides MacGinitie. Chaney and Elias, Carnegie Inst. Wash. Pub. 476, p. 42, pl. 7, fig. 10 only, 1936.

Ten leaflets in our collections, four each from the Mascall and Stinking Water floras, and one each from the Lower Idaho and Elko floras, are identified as Gymnocladus. Close relationship to Gymnocladus dioicus K. Koch, the Kentucky coffee tree, is shown by the oval to lanceolate leaflets, their medium thin texture, the details of finer nervation, and the thick petiolule with transverse striations. This tree is distributed primarily in the low, rich bottom lands of the central United States west of the Appalachian Mountains. It ranges from central New York southward to Tennessee and Arkansas and northward through eastern Oklahoma, Kansas, and Iowa to the southern Great Lakes states. Typical associates include various species of Carya, Juglans, Nyssa, Quercus, and Ulmus which have close relatives in the Mascall flora.

One of the two type specimens of Salix dayana represents the oak Quercus dayana, but the other is clearly a leguminous leaflet, and is well within the range of leaflet variation displayed by the living Gymnocladus dioicus. The leaflets shown on sheets 2031015 and 1730268 in the U. S. National Herbarium include some of lanceolate shape like the type specimen, as well as more typical oval to ovate leaflets such as those which we are figuring for the Mascall and which have been illustrated for other floras. Since all the material cited above is well within the range of variation of one modern plant, it seems best to recognize only one fossil species.

We are placing the Succor Creek leaflets referred to Meibomites lucens Knowlton in synonymy under G. dayana. Brooks originally pointed out their close resemblance to G. dioicus but hesitated to refer them to G. casei Berry because of certain differences in shape. With the limited material then at hand from Succor Creek, Brooks did not consider it advisable to describe a new species of Gymnocladus. She compared the Succor Creek specimens with the Latah M. lucens Knowlton, which was then considered a synonym of Cercis spokanensis Knowlton, but is now interpreted as Exbucklandia (Brown, 1946). The Succor Creek fossils are well within the range of variation of G. dayana, as exemplified by the Beaver Creek, Mascall, Elko, Lower Idaho, and Stinking Water material, and all are duplicated easily by leaflets of the modern American species.

Gymnocladus chinensis Lamarck of central and southern China differs from both G. dayana and the modern American G. dioicus in having oblong leaflets of heavy texture. Gymnocladus miochinensis Hu and Chaney from the Shangwang flora of northern China is more clearly related to this living Asiatic species than to either the Mascall or the modern American species of the genus (Hu and Chaney, 1938).

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P28, P4129), hypotypes nos. 3149, 3149a, homeotype no. 3150. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotype no. 3151, homeotypes nos. 3152, 3153. Succor Creek, Ore.: Carnegie Mus. Lower Idaho, Ida.: U. C. M. P. (loc. P635), hypotype no. 3154.

## Family RUTACEAE

### Ptelea miocenica Berry

(Plate 37, figures 5, 6)

Ptelea miocenica Berry, U. S. Geol. Surv. Prof. Paper 170, p. 39, pl. 12, fig. 7, 1931.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 178, pl. 51, figs. 4, 5, 1937 (see synonymy and discussion).
Nyssa knowltoni Berry, U. S. Geol. Surv. Prof. Paper 154, p. 261, pl. 59, fig. 7, 1929.
Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, p. 97, pl. 8, figs. 1, 5, 1937.

Ptelea fruits are rare in our collections, two being present in the Mascall flora and one in the Stinking Water. Leaflets of the hop tree have not been certainly identified in these floras, but are represented in the Latah by material previously known as Nyssa knowltoni Berry (Brown, 1946).

Ptelea is confined today to the United States and Mexico. The exact specific limits of members of the genus have been treated differently by botanists, some of whom recognize about 6 and others as many as 57 American species. The species range through a wide variety of habitats, from the moist deciduous forests of the eastern United States to the semiarid woodlands and desert-border sites of the western United States and northern Mexico, and southward into warm-temperate forests in Oaxaca. It seems probable that the diversity of species recognized by Greene and Rose is in large measure a reflection of the different habitats in which Ptelea is found. Our Miocene species seems most nearly related to the modern Ptelea trifoliata Linnaeus of the eastern United States, though its affinity with P. baldwinii Torrey and Gray of the western United States is also apparent.

The fruits of P. cassiodes (Lesquereux) MacGinitie from the Florissant flora of Colorado are much like those from the Miocene of the Pacific region, and as MacGinitie (1953, p. 129) notes, they may well represent the same species.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P28), hypotype no. 3155, homeotype no. 3156. Stinking Water, Ore.: U. C. M. P. (loc. P4006), hypotype no. 3157. Succor Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P3742), hypotype no. 3158. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), homeotype no 602. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotype no. 809. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.); U.C.M.P. (loc. P635), hypotypes nos. 1218, 1219. Latah, Wash.: U.S.N.M. (Grand Coulee, Spokane locs.).

## Family SIMARUBACEAE

### Ailanthus indiana (MacGinitie) Brown

(Plate 38, figures 1, 2)

Ailanthus indiana (MacGinitie) Brown, Jour. Wash. Acad. Sci., vol. 30, p. 351, 1940.
Apocynum indiana MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 66, pl. 12, fig. 1, 1933.
Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 117, pl. 6, fig. 1; pl. 7, fig. 2, 1939.
Ailanthus ? americana Cockerell. Oliver, Carnegie Inst. Wash. Pub. 455, p. 23, 1934.
Ailanthus lesquereuxi Cockerell. Arnold, Contr. Univ. Mich., Mus. Pal., p. 95, pl. 8, figs. 3, 4, 1937.
Sapindus oregonianus Knowlton. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 37, pl. 1, fig. 5; pl. 2, fig. 3; pl. 3, fig. 4, 1935.

Ailanthus was not a common tree in Miocene floras of the Columbia Plateau area. Its record from the Blue Mountains and Stinking Water floras is limited to a single characteristic winged fruit in each, and in the Trout Creek and Succor Creek floras it is represented by only a few leaflets and fruits.

The Upper Cedarville leaflets of Sapindus oregonianus Knowlton cited in the synonymy above have the large teeth and undulating margin in the lower part of the blade that are typical of Ailanthus, and we therefore transfer them to the Miocene species Ailanthus indiana.

Fruits of A. americana Cockerell (MacGinitie, 1953, p. 129) and A. lesquereuxi Cockerell (Brown, 1934, p. 59) are present but not abundant in the Florissant and Green River floras of the Rocky Mountain province. These species have been considered distinct from A. indiana, but additional material may demonstrate that they cannot be separated morphologically. Another related species is A. youngi Hu and Chaney from the Shangwang flora of northern China (Hu and Chaney, 1938), a flora containing many species closely related to those in the Miocene of the western United States.

All the fossil species show close relationship to the leaflets and fruits produced by the living A. altissima Swingle, native to the mountain region of southwestern and western China. MacGinitie has noted that there are some differences between the fruits of the Eocene and Oligocene species and those of A. altissima; these include smaller size, more ovate form, and relatively larger seeds in the Tertiary as compared with the living species (MacGinitie, 1953, p. 130).

Occurrence. Blue Mountains, Ore.: U. C. M. P. (loc. P3936), hypotype no. 692. Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotype no. 3159. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), holotype no. 628. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotypes nos. 164, 167, 170. Succor Creek, Ore.: U. M. M. P.

## Family MELIACEAE

### Cedrela trainii Arnold

(Plate 38, figures 3, 5-9)

Cedrela trainii Arnold, Amer. Mid. Naturalist, vol. 17, p. 1018, figs. 1, 2, 1936.
Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, no. 8, p. 95, pl. 6, figs. 1-3, 6, 1937.
Cedrela browniana Arnold, Amer. Mid. Naturalist, vol. 17, p. 1019, fig. 11, 1936.
Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, no. 8, p. 95, pl. 7, figs. 1, 2, 1937.
Cedrela pteraformis (Berry) Brown. Arnold, ibid., p. 95, pl. 6, figs. 4, 7-10, 1937.
Cedrela sp. capsule Arnold, Amer. Mid. Naturalist, vol. 17, p. 1018, fig. 3, 1936.
Cedrela sp. seeds of Arnold, ibid., p. 1018, figs. 4-10, 1936.
Sapindus affinis Newberry ? MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 60, 1933.
Sapindus oregonianus Knowlton. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 37, pl. 1, fig. 2; pl. 2, figs. 1, 2, 4; pl. 3, fig. 2, 1935.
Pinus monticolensis Berry. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 110, pl. 5, figs. 1, 4, 1936.
Pseudotsuga masoni MacGinitie. LaMotte, ibid., p. 111, pl. 3, figs. 6, 7, 1936.
Fraxinus idahoensis Brown. LaMotte, ibid., p. 141, pl. 12, fig. 5, 1936.
Libocedrus sp. Dorf, Carnegie Inst. Wash. Pub. 476, p. 108, pl. 1, fig. 4, 1936.

We have selected the specific name trainii for our material because the name Cedrela oregoniana (Lesquereux) Brown cannot be applied to Cedrela. The name is derived from Ficus ? oregoniana Lesquereux, which clearly represents a leaf of persimmon. It forms the basis of a new combination, Diospyros oregoniana (Lesquereux) Chaney and Axelrod, under which are grouped all specimens previously recorded as

Diospyros andersonae Knowlton. We have therefore chosen Cedrela trainii Arnold as the next most appropriate name for Cedrela in the Mascall and related floras. We further identify as C. trainii all material listed by Brown (1937b, p. 513) as C. oregoniana (Lesquereux) Brown except Apocynum indiana MacGinitie, which seems more properly referable to Ailanthus, and is the type of A. indiana (MacGinitie) Brown (Brown, 1940, p. 351). Cedrela trainii differs from C. pteraformis (Berry) Brown, which is now known only from the Latah flora, in having relatively large leaflets with tapering tips rather than small leaflets with an elliptic outline and blunt tips.

Cedrela is common in the Mascall flora, where it is represented by 4 asymmetrical, lanceolate leaflets and by numerous seeds. Its Stinking Water record is more limited, including 1 leaflet and 4 seeds. Brown earlier recorded Cedrela in the Blue Mountains flora, but this capsule, like 2 others we have collected there, represents Gordonia; Cedrela is not now known in the Blue Mountains flora.

Cedrela is one of the characteristic genera in the Middle Tertiary floras of the western United States, having been identified in the Bridge Creek, Latah, Mascall, Stinking Water, Succor Creek, Thorn Creek, Trout Creek, Upper Cedarville, and Lower Idaho floras of the Columbia Plateau region. It has not yet been recorded in floras above the Mio-Pliocene transition in the western United States.

Cedrela occurs today in the Asian and American tropics and border areas, where it may range into regions characterized by moderate frost. The Miocene species seems more nearly allied to living American than to Asian species of the genus, since leaves of the fossil and modern American species are entire-margined, whereas those of Asiatic species often are serrate as well as entire. Among the modern American species showing relationship to C. trainii are C. odorata Linnaeus of the West Indies and C. mexicana Roemer, which ranges northward to southern Sonora.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P3735, P3737, P4123, P28, P4129), hypotypes nos. 3160, 3161, 3162, 3164, homeotype no. 3163. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), hypotype no. 3166, homeotypes nos. 3165, 3167. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275, homeotype no. 619. Succor Creek, Ore.: U. M. M. P; U. C. M. P. (locs. P3745, P3746, P3747). Upper Cedarville, Cal.-Nev.: U. C. M. P. (locs. P97, P115), hypotypes nos. 162, 165, 166, 168, 169, 171, 775, 776, 781, 814, 867. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.); U. M. M. P.; U. C. M. P. (loc. P635, hypotype no. 1164, homeotypes nos. 1165, 1166. Thorn Creek, Ida.: U. C. M. P. (loc. P4600), hypotype no. 3168.

## Family AQUIFOLIACEAE

### Ilex fulva MacGinitie

(Plate 38, figure 10)

Ilex fulva MacGinitie, Carnegie Inst. Wash. Pub. 465, p. 145, pl. 10, figs. 1, 2; pl. 12, fig. 1, 1937.

Ilex fulva has previously been known only from the Weaverville flora of northwestern California. We have found a single leaf of this species in our collections from the Latah formation at Grand Coulee, which we are here recording and illustrating. The fossil occurs with a typical Latah flora at this locality, some seven miles from the dam site. Among its associates are Taxodium dubium, Cocculus heteromorpha, Ulmus speciosa, Fagus washoensis, Sophora spokanensis, and Platanus dissecta.

Ilex fulva MacGinitie and the related I. lomensis Condit and I. sinuata Chaney and Axelrod all appear to be extinct species in so far as close modern counterparts are concerned. They show a general relationship to I. aquifolium Linnaeus and I. dipyrena Wall, evergreen shrubs of Europe and eastern Asia. One important difference, besides size and the shape of the sinuses, is that the fossils are nearly apetiolate.

Occurrence. Latah, Wash.: U. C. M. P. (loc. P4023), hypotype no. 5127.

### Ilex sinuata new species

(Plate 38, figures 4, 11)

Mahonia reticulata (MacGinitie) Brown. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 175, pl. 52, fig. 4, 1937.

Description. Leaf lanceolate; total length unknown, estimated at about 8 cm.; base rounded to auriculate; width 3.3 to 4.5 cm.; petiole very short, not more than 2 to 3 mm. long; midrib thick and straight; alternate secondaries diverging at about 45° and then immediately increasing the angle to about 85° and entering marginal lobes; major intersecondaries departing at 40° to 45°, extending toward edge of sinuses, and then looping upward along margin, those in lower part of blade diverging at 70° to 85°, looping upward to join those above well within the margin; tertiaries forming large, irregular polygons; finer mesh not preserved; margin coarsely dentate, with outward-pointing, heavy spine tips, the sinuses deep; texture leathery.

Discussion. These coriaceous, deeply lobed leaves cannot be matched by any living species of Ilex that we have seen in various herbaria. They resemble the leaves of Ilex opaca Aiton of the eastern United States and I. dipyrena Wall of eastern Asia, but differ from them in their larger size, deeper sinuses, and shorter petiole. It nonetheless seems probable that both the modern and the fossil forms were derived from the same ancestral species. The fossil leaves differ from Mahonia, with which they were at first confused, in that the secondaries enter the marginal lobes directly; in Mahonia the secondaries loop well within the margin and a tertiary extends into the teeth.

Among the several fossil species of Ilex described from the western United States, *I. sinuata* generally resembles *I. fulva* MacGinitie from the Weaverville (MacGinitie, 1937, pl. 10, figs. 1, 2; pl. 12, fig. 1) and *I. lomensis* Condit from the Neroly flora (Condit, 1938, pl. 7, figs. 3, 4). It differs from both in its intermediate size, deeper sinuses, and thicker texture.

*Occurrence*. Blue Mountains, Ore.: U. C. M. P. (locs. P3936, P3937), holotype no. 3170, paratype no. 3169, homeotype no. 3171.

## Family ACERACEAE

### *Acer bendirei* Lesquereux

(Plate 38, figure 12; plate 39, figures 1-6)

*Acer bendirei* Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 14, pl. 8, fig. 1 only, 1888.
Smith, Bull. Torrey Bot. Club, vol. 65, p. 561, pl. 29, fig. 4, 1938.
*Acer osmonti* Knowlton, U. S. Geol. Surv. Bull. 204, p. 72, pl. 13, fig. 3, 1902.
Chaney, Carnegie Inst. Wash. Pub. 346, p. 126, pl. 17, fig. 6, 1927.
Dorf, Carnegie Inst. Wash. Pub. 476, p. 121, 1936.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 180, pl. 58, figs. 16-18, 1937.
Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 25, p. 116, pl. 3, fig. 1 (not fig. 6, which is *A. bendirei* Lesquereux); pl. 4, fig. 1, 1939.
*Acer gigas* Knowlton, U. S. Geol. Surv. Bull. 204, p. 76, pl. 14, fig. 1, 1902.
*Acer chaneyi* Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 45, pl. 27, fig. 2, 1926.
Berry, U. S. Geol. Surv. Prof. Paper 154, p. 256, pl. 63, fig. 13, 1929.
MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 61 (part), 1933.
Oliver, Carnegie Inst. Wash. Pub. 455, p. 26, pl. 5, fig. 3, 1934.
Brooks, Ann. Carnegie Mus., vol. 24, p. 297, pl. 21, fig. 1a, 1935.
Dorf, Carnegie Inst. Wash. Pub. 476, p. 120, 1936.
*Quercus* cf. *Q. pseudolyrata* Lesquereux. Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 36, pl. 22, fig. 2, 1926.
*Acer oregonianum* Knowlton. Berry, U. S. Geol. Surv. Prof. Paper 185, p. 118, pl. 24, fig. 1, 1934.
*Acer merriami* Knowlton. Berry, U. S. Geol. Surv. Prof. Paper 154, p. 256, 1929.
*Rhus diluvialis* Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, no. 8, p. 93, pl. 5, fig. 4, 1937.
*Quercus malheurensis* Smith, Bull. Torrey Bot. Club, vol. 65, p. 560, pl. 29, fig. 1, 1938.
*Rhus oregonensis* Smith, ibid., p. 561, pl. 29, fig. 9, 1938.
*Engelhardtia tuckeri* Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 23, p. 226, pl. 1, fig. 4, 1938.

*Acer bendirei* is represented by several samaras and leaves in both the Mascall and Blue Mountains floras, and by 2 samaras in the Stinking Water collections. All the material we have identified as *A. bendirei* is closely similar to the leaves and fruits of the modern silver maple, *A. saccharinum* Linnaeus, of the eastern United States.

Three of the 4 specimens originally regarded by Lesquereux (1888), and later by Knowlton (1902), as representing *A. bendirei* are now known to be *Platanus dissecta* Lesquereux. There is no doubt that the remaining leaf (Lesquereux, 1888, pl. 8, fig. 1) represents a maple. Brown (1937a, p. 179) earlier considered it a *macrophyllum*-type maple. We have questioned this comparison, and Brown now agrees with us that the type of *A. bendirei* is more nearly matched by 3-lobed leaves of the living *A. saccharinum*. A critical feature that aligns it with this species rather than *A. macrophyllum* is the nature of the sinuses between the marginal teeth; although Lesquereux's illustration shows them as scalloped (as they should be in a *macrophyllum*-type maple), examination of the specimen shows that the sinuses between the teeth are angular, like those of the living *A. saccharinum*.

As for specimens of the *macrophyllum* alliance that had previously been designated as *A. bendirei*, the next oldest name is *Acer dimorphum* Lesquereux (1888, pl. 9, fig. 1). Brown earlier placed it in synonymy under *A. bendirei*, but after examining the specimen we have been unable to determine with any certainty that it is a maple of the *macrophyllum* type. The specimen is fragmentary and poorly preserved, and sufficient characters for positive identification are not present; it might possibly represent a somewhat abnormal leaf of Platanus. We therefore believe that the soundest procedure is to relegate *A. dimorphum* Lesquereux to *nomen dubium*. We are resurrecting the name *Acer oregonianum* Knowlton (1902, pl. 13, figs. 5, 7, 8) for fossil maples of the *A. macrophyllum* alliance.

It seems likely that incomplete leaves of *A. bendirei* might be confused with those of *A. glabroides* Brown. They may usually be distinguished by the fact that *A. glabroides* has short and blunt lobes, not slender and tapering as in *A. bendirei*.

As shown by the listing below, *A. bendirei* was one of the commoner maples in Miocene floras of the Columbia Plateau and adjacent regions.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735, P4129, P4123), hypotypes nos. 3178, 3179, homeotypes nos. 3176, 3177. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotypes nos. 702, 3172, 3173, homeotypes nos. 701, 3174, 3175. Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotypes nos. 3180, 3181. Trout Creek, Ore.: U. C. M. P. (loc. P275), homeotype no. 3182. Succor Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P3744). Lower Idaho, Ida.: U. C. M. P. (locs. P635, P636, P638), hypotype no. 1224, homeotypes nos. 1221, 1222, 1223. Payette, Ida.: U. C. M. P. (loc. P3743), hypotype no. 3183. Thorn Creek, Ida.: U. C. M. P. (loc. P4600). Latah, Wash.-Ida.: U. S. N. M. (Spokane, Whitebird, Coeur d'Alene locs.).

### Acer bolanderi Lesquereux

(Plate 39, figures 7-12; plate 40, figure 7)

Acer bolanderi Lesquereux, Mem. Harvard Mus. Comp. Zoöl., vol. 6, no. 2, p. 27, pl. 7, figs. 7-11, 1878.
Condit, Carnegie Inst. Wash. Pub. 553, p. 85, pl. 19, figs. 5, 6, 1944.
Acer minor Knowlton, U. S. Geol. Surv. Bull. 204, p. 76, pl. 14, fig. 2 only, 1902.
Acer medianum Knowlton, ibid., p. 76, pl. 14, figs. 4, 5, 1902.
Acer merriami Knowlton, Dorf, Carnegie Inst. Wash. Pub. 476, p. 120, pl. 3, fig. 8, 1936.
Acer osmonti Knowlton. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 137 (part) (not pl. 12, fig. 6, which is A. glabroides Brown), 1936.
Acer sp. samaras Smith, Amer. Mid. Naturalist, vol. 25, p. 518, pl. 12, figs. 5, 6, 1941.
Acer fruit Berry, U. S. Geol. Surv. Prof. Paper 170, p. 34, 1931.
Ribes sp. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 128, pl. 9, fig. 2, 1936.

Maple leaves in the Mascall flora representing Acer bolanderi are similar to those of the modern A. saccharum group, including such species as A. grandidentatum Nuttall, A. saccharum Marshall, A. leucoderme Small, and A. floridanum Pax. One difference is that in A. bolanderi there is a greater tendency for the middle lobe of the leaf to be somewhat longer than the laterals, thus giving the leaf a greater length than width; such variation may be found in the living species which resemble it most closely, though it is more noticeable in A. bolanderi. Similar variation is seen in the large suite of specimens representing A. bolanderi at its type locality at Table Mountain.

Proper identification of the samaras representing this species is not easy, for samaras of the modern saccharum group may resemble those of the living A. macrophyllum, which is represented in the Mascall flora by A. oregonianum Knowlton. In general, we have found that the samaras of A. bolanderi are somewhat smaller than those of oregonianum. There is also an important difference in shape: the seeds of bolanderi, like those of the saccharum group, are essentially oval, whereas those of A. oregonianum, like those of the living A. macrophyllum, are broadly triangular in outline. On the basis of these differences in size and shape of the samaras we believe that the types of A. minor Knowlton (in part) and A. medianum Knowlton belong to A. bolanderi rather than to A. oregonianum, where they were earlier placed by Brown (1937a, p. 179).

Examination of the leaf figured by LaMotte as Ribes sp. shows that it is no more than a small leaf of A. bolanderi, several of which are present in the collection from Upper Cedarville locality P97; the teeth which have been drawn on the specimen are not present.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735, P4123, P4129), hypotypes nos. 3184-3189 incl. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), homeotypes nos. 3190, 3191. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotypes nos. 800, 5128, homeotypes nos. 858, 859, 860. Thorn Creek, Ida.: U. M. M. P. Lower Idaho, Ida.: U. S. N. M. (Hog Creek loc.). Latah, Wash.: U. S. N. M. (Grand Coulee loc.).

### Acer columbianum new species

(Plate 40, figures 1-3, 5)

Acer osmonti Knowlton. MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 62 (part), 1933.
Brooks, Ann. Carnegie Mus., vol. 24, p. 298, pl. 20, fig. 2, 1935.
Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 116, pl. 3, fig. 6 (not fig. 1, which is A. bendirei Lesquereux), 1939.

Description. Leaves 3-lobed, broadly oval in outline, the lobes characteristically blunt and not strongly tapering to acuminate tips, the base broadly rounded, truncate, or subcordate, the sinuses acute, extending in well over half the length of the blade; length 2.5 to 5.5 cm., width 3.0 to 6.0 cm.; petiole slender, up to 3.5 cm. long; palmately 3-nerved, the lateral primaries diverging from the top of the petiole at angles averaging 50° to 60°, rarely as high as 80°; 2 to 3 secondaries diverging from midrib at about 35°, becoming thinner above, somewhat looping; 3 to 4 abaxial and adaxial secondaries on lateral lobes, the middle one the stronger and supplying a lobe, the secondaries otherwise thin and looping; thin looping tertiaries from secondaries extend to marginal area, subcamptodrome; tertiary pattern irregular, enclosing a polygonal mesh with nervilles ending in conspicuous crossties; margin biserrate, the teeth often small and not well preserved; texture thin.

Samaras 2.2 to 2.6 cm. long, the wing widened in middle and outer part, reaching under the seed; seed oval, surface smooth but with a deep wrinkle.

*Discussion*. *Acer columbianum* is most similar to leaves and samaras of the modern *A. glabrum* Torrey of western North America. It differs from *A. glabroides* Brown, which is like *A. rubrum* Linnaeus of the eastern United States, in having generally smaller and more dissected leaves. The sinuses are narrow and deep, not wide as in *A. glabroides*, and the lobes are commonly widened in the outer part rather than acute like those of *glabroides*. Many of the leaves of *glabroides* tend to be subcuneate, a feature not encountered in *columbianum*. There is also a difference in texture, the leaves of *glabroides* tending to be firmer and thicker than those of *columbianum*. The samaras are much alike in outline, but may be distinguished readily by the surface pattern of the seed. Those of *columbianum* are smooth with one or more deep wrinkles, whereas those of *glabroides* have prominent anastomosing veins.

*Acer glabrum* is a much-branched shrub, or rarely a small tree, distributed widely over the western part of the continent. It ranges from Alaska southward through the Rocky Mountains into Arizona and along the Cascades and Sierra Nevada into southern California. It is represented by several varieties over its range, where it is found with the North-Coast Coniferous, Sierra-Cascade, and Rocky Mountain forests in environments of the Transition and Canadian life zones.

*Occurrence*. Mascall, Ore.: U. C. M. P. (locs. P3735, P4123, P28, P4129), holotype no. 5129, homeotypes nos. 5130, 5131. Stinking Water, Ore.: U. C. M. P. (locs. P4006, P4120), paratypes nos. 5132, 5133. Trout Creek, Ore.: U. C. M. P. (loc. P275), hypotype no. 608, homeotype no. 609. Succor Creek, Ore.: U. M. M. P.; Carnegie Mus.

## *Acer glabroides* Brown

(Plate 40, figures 4, 6, 8-11; plate 41, figures 1, 2)

*Acer glabroides* Brown, U. S. Geol. Surv. Prof. Paper 186, p. 180, pl. 58, figs. 13-15, 1937.
Smith, Amer. Mid. Naturalist, vol. 25, p. 516, pl. 12, figs. 4, 10, 1941.
*Acer trilobatum productum* ? Heer. Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 733, pl. 102, fig. 3, 1898.
*Acer osmonti* Knowlton. Chaney, Carnegie Inst. Wash. Pub. 346, p. 126, pl. 18, figs. 1, 3, 5, 1927.
MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 62 (part), 1933.
Oliver, Carnegie Inst. Wash. Pub. 455, p. 24, 1934.
LaMotte, Carnegie Inst. Wash. Pub. 455, p. 138, pl. 12, fig. 6 (part), 1936.
*Acer bendirei* Lesquereux. Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 45, pl. 27, fig. 3, 1926.
*Acer florissanti* Kirchner. Berry, U. S. Geol. Surv. Prof. Paper 185, p. 118, pl. 24, figs. 5-7, 1934.
*Tilia aspera* (Newberry) LaMotte, Carnegie Inst. Wash. Pub. 455, p. 45 (part), 1935.
*Acer scottiae* MacGinitie. Smith, Amer. Mid. Naturalist, p. 516, pl. 12, fig. 9 only, 1941.
*Acer chaneyi* Knowlton. Brooks, Ann. Carnegie Mus., vol. 24, p. 297, pl. 19, fig. 5, 1935.
*Acer minor* Knowlton. Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 45, pl. 27, fig. 4, 1926.
Berry, U. S. Geol. Surv. Prof. Paper 154, p. 256, pl. 64, fig. 2, 1929.
*Acer bolanderi* Lesquereux. Smith, Bull. Torrey Bot. Club, vol. 65, p. 562, pl. 28, fig. 5; pl. 29, fig. 8, 1938.
Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 116, pl. 3, fig. 3, 1939.

The revised synonymy presented above for *Acer glabroides* excludes several plants listed by Brown which are referable to *A. osmonti*, and includes several additional species. All the plants that we list under *A. glabroides* find their nearest modern relative in *A. rubrum* Linnaeus, not *A. glabrum* Torrey as suggested by Brown. The following leaf description of this species is based on material from the Thorn Creek flora, where a complete range of leaf variation closely paralleling that of the living red maple is shown; the samara description is based on fossils from the Blue Mountains and Upper Cedarville floras.

*Description*. Leaves 3- and 5-lobed, some of the 3-lobed leaves with much reduced lobes, apex acute, base subcordate to rounded and subcuneate; 2 to 9 cm. long, averaging 4.5 to 7 cm., width in 3-lobed leaves less than length, 2 to 3 cm. in leaves 4 to 5 cm. long, width generally equaling length in 5-lobed leaves, subcordate leaves averaging 8 to 10 cm. broad in leaves 7 to 8 cm. long; petiole of medium thickness, up to 4 cm. long in largest leaves; midrib firm, straight or wavering above, and tapered; main primaries diverging from top of petiole at 35° to 40° in the larger 5-lobed leaves, at 25° to 35° in the 3-lobed leaves, the lower pair diverging at about 85° to 90° in 5-lobed leaves, or at 120° in subcordate leaves, and reduced to a submarginal vein in 3-lobed leaves; 3 to 5 large secondaries, the first main secondaries above the primaries diverging from midrib at 30° to 60°, averaging 35° to 40°, entering marginal teeth; strong abaxial tertiaries from primaries join marginal area and prominent tertiaries from secondaries extend into marginal area or to teeth in outer part of blade; tertiaries irregularly percurrent within the blade; finer mesh of large polygons enclosing a fine quadrangular mesh; margin serrate in largest leaves, fewer teeth in smaller leaves to a pseudo-entire margin in some cases; texture medium.

Samaras 2.1 to 2.5 cm. long, wing 6 to 8 mm. wide at point of greatest breadth; the wing reaching up under the seed; nutlet ovate in outline, with a characteristic sculpturing of anastomosing veins which form polygons paralleling the length of the nutlet.

Discussion. An analysis of the leaf and samara characters of these fossils shows quite clearly that they are more closely related to the living A. rubrum than to A. glabrum. The red maple affinity is seen in the short lobes with wide sinuses; the angle of the sinus often equals 90° in rubrum, but it is much smaller in glabrum, and commonly has a deep, acute notch at the base. The fossil leaves commonly tend to have a subcuneate base like rubrum, a rare feature in glabrum. A third feature that brings glabroides into the rubrum alliance is the fact that the leaves have fewer and less prominent marginal teeth than glabrum, and they may often be essentially entire. The samaras of glabroides have characteristic anastomosing veins on the seed much like those of rubrum, whereas those of glabrum have a smooth surface broken by a deep wrinkle. In addition, the seed of glabroides is rounded where it joins the wing like those of rubrum, but those of glabrum tend to be acute.

Red maple, A. rubrum, is a common and widely distributed tree in eastern North America, extending from New Brunswick to northern Wisconsin and southward to eastern Texas and central Florida. It is found commonly along riverbanks and in swamps at lower elevations, but also ranges upward to 4500 feet in the central Appalachian Mountains. Red maple is a regular member of the beech-maple and oak-hickory forests, many species of which have relatives in the Miocene floras of the western United States.

Previously described fossils showing relationship to A. glabroides are A. trilobatum productum (Al. Braun) Heer (Knowlton, 1904, pl. 29, fig. 2), A. disputabilis Hollick (Hollick, 1936, pl. 74, fig. 4) from the Early Tertiary of Alaska, and A. otopteryx Heer (Heer, 1868, vol. 1, pl. 28, figs. 1-8) from Iceland. In the Miocene of Europe Acer trilobatum Al. Braun and several of its varieties (Heer, 1859, vol. 3, pp. 47 ff., pls. 110-117) are quite similar to A. glabroides and to A. rubrum. Acer florissanti Kirchner, which is well represented in the Florissant flora (MacGinitie, 1953), is closely allied to A. glabroides; there are sufficient differences to indicate that they are distinct, though closely related, species. The tips of the leaf lobes in A. florissanti tend generally to be acuminate, in contrast to the blunt and acute tips of A. glabroides. The base of the leaves in A. florissanti is commonly truncate to rounded or rarely subcordate, whereas in A. glabroides the base is often subcuneate as well. The lateral leaf lobes of A. glabroides may often be much reduced in size, a feature not common in A. florissanti. In addition, the marginal teeth of A. glabroides are often more suppressed than in A. florissanti.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P28, P3735, P4123), hypotype no. 3202. Blue Mountains, Ore.: U. C. M. P. (locs. P3936, P3937), hypotypes nos. 3203, 3204, homeotypes nos. 694, 695. Trout Creek, Ore.: U. C. M. P. (loc. P275), homeotype no. 610. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), homeotype no. 861. Thorn Creek, Ida.: U. M. M. P.; U. C. M. P. (loc. P4600), hypotypes nos. 3206-3210 incl., homeotype no. 3205. Succor Creek, Ore.: U. M. M. P.; Carnegie Mus. Payette, Ida.: U. S. N. M. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Whitebird locs.).

### Acer minor Knowlton

(Plate 41, figures 3-5)

Acer minor Knowlton, U. S. Geol. Surv. Bull. 204, p. 76, pl. 14, fig. 3 (not fig. 2, which is A. oregonianum Knowlton), 1902.
Acer aquilum Chaney, Contr. Walker Mus., vol. 2, p. 178, pl. 17, figs. 4, 5; pl. 18, fig. 1; pl. 19, fig. 1, 1920.
Crataegus heterodentata Chaney, ibid., p. 175, pl. 17, figs. 1, 2, 1920.
Liriodendron trilobata Chaney, ibid., p. 173, pl. 14, fig. 4, 1920.
Acer heterodentatum (Chaney) MacGinitie, Carnegie Inst. Wash. Pub. 599, p. 140, pl. 57, fig. 3, 1953.
Acer oregonianum Knowlton. Berry, U. S. Geol. Surv. Prof. Paper 154, p. 255, pl. 57, fig. 2; pl. 63, fig. 11, 1929.
Acer negundoides MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 62, pl. 11, figs. 2, 3, 1933.
  Brown, Jour. Paleontol., vol. 9, p. 580, pl. 69, figs. 9-11, 1935.
  Dorf, Carnegie Inst. Wash. Pub. 476, p. 121, pl. 3, fig. 2, 1936.
  Chaney and Elias, Carnegie Inst. Wash. Pub. 476, p. 42, pl. 7, fig. 11 only, 1936.
  LaMotte, Carnegie Inst. Wash. Pub. 455, p. 136, pl. 12, fig. 3 (not fig. 4, which is incertae sedis), 1936.
  Brown, U. S. Geol. Surv. Prof. Paper 186, p. 180, pl. 58, fig. 1, 1937.
  Chaney, Carnegie Inst. Wash. Pub. 476, p. 216, pl. 6, fig. 2; pl. 7, fig. 1, 1938.
  Smith, Bull. Torrey Bot. Club, vol. 65, p. 562, pl. 29, fig. 5, 1938.
  Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 23, p. 228, pl. 1, fig. 13, 1938.
  Chaney, Carnegie Inst. Wash. Pub. 553, p. 320, pl. 53, figs. 2, 4, 1944.
Acer cf. A. negundoides MacGinitie. Brooks, Ann. Carnegie Mus., vol. 24, p. 298, pl. 21, fig. 2, 1935.
Acer osmonti Knowlton. Chaney, Carnegie Inst. Wash. Pub. 346, p. 126, pl. 18, fig. 7 only, 1927.
Acer fruits Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 15, pl. 6, fig. 2 only; pl. 7, fig. 2, 1888.

Samaras of the Acer negundo type are abundant in the Mascall flora and common at Stinking Water, but have not been identified in the Blue Mountains collection. Four fragmentary leaflets representing the lateral and terminal parts of a negundo-type maple are in our recent Mascall collections, but leaflets have not been recognized in the material from Stinking Water.

Acer minor was a common tree on the Columbia Plateau and in border areas in Miocene time, and has been recorded at Latah, Mascall, Eagle Creek, Thorn Creek, Succor Creek, Stinking Water, Upper Cedarville, Lower Idaho, and Trout Creek. It survived in this region into the Pliocene in the Dalles and Deschutes floras (Chaney, 1938b, 1944b), and is represented also in the Lower Pliocene Beaver Creek (Laverne) flora of Oklahoma (Chaney and Elias, 1936). It is still unrecognized in the California Pliocene, which is surprising in view of the fact that A. negundo Linnaeus is found widely distributed there today along river and stream borders.

Acer minor is the oldest name that has been applied to a fossil box elder based on adequate material. The leaves figured by Knowlton (1902) as Phyllites bifurces and Rulac crataegifolium are considered by Brown (1937a, p. 180) and LaMotte (1952, p. 53) to represent a maple of the negundo type. Phyllites bifurces is represented by an incomplete specimen, yet it seems to have all the characters of negundo leaves; the name bifurces cannot be applied, however, because A. minor has page priority. Rulac crataegifolium was considered by Knowlton to represent a box elder, and LaMotte has made a new combination of it for all fossil box elders. As Brown (1937a, p. 180) and MacGinitie (1953, p. 141) have pointed out, the specimen is so fragmentary that its real identity will always be open to question. Although Knowlton thought it was part of a deeply 3-lobed leaf, it seems more nearly to represent the 2 lower lateral right lobes of a 5-lobed maple; the character of the marginal teeth seems to align it more nearly with A. bendirei than with any other species. Since its true character cannot be certainly established, it seems best to relegate it to nomen dubium. The Eagle Creek specimens cited above also represent box elder, but since the names do not have priority over A. minor we cannot accept the new combination Acer heterodentatum (Chaney) MacGinitie proposed by MacGinitie (1953).

Occurrence: Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735, P4123, P4129), hypotype no. 3196, homeotypes nos. 3197, 3198, 3199. Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotype no. 3200, homeotype no. 3201. Trout Creek, Ore.: U. C. M. P. (loc. P275), holotype no. 617, paratype no. 618. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotypes nos. 815, 820, homeotype no. 857. Lower Idaho, Ida.: U. C. M. P. (loc. P635), hypotype no. 1225, homeotypes nos. 1226, 1227. Thorn Creek, Ida.: U. C. M. P. (loc. P4600), hypotype no. 3211. Latah, Wash.: U. S. N. M. (Spokane loc.). Succor Creek, Ore.: U. M. M. P.; Carnegie Mus.

### Acer oregonianum Knowlton

(Plate 41, figures 11-14)

Acer oregonianum Knowlton, U. S. Geol. Surv. Bull. 204, p. 75, pl. 13, figs. 5, 7, 8 (not fig. 6, which is A. scottiae MacGinitie), 1902.
Jennings, Mem. Carnegie Mus., vol. 8, no. 2, p. 423, pl. 32, fig. 3, 1920.
Oliver, Carnegie Inst. Wash. Pub. 455, p. 24, 1934.
Acer fruits Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 15, pl. 6, fig. 3 only, 1888.
Acer merriami Knowlton. Berry, U. S. Geol. Surv. Prof. Paper 170, p. 39, pl. 13, fig. 13, 1931.
MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 61, pl. 10, fig. 1, 1933.
LaMotte, Carnegie Inst. Wash. Pub. 455, p. 135, pl. 12, fig. 7, 1936.
Acer septilobatum Oliver, Carnegie Inst. Wash. Pub. 455, p. 25, pl. 4, figs. 1, 2, 1934.
Acer bendirei Lesquereux. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 179, pl. 58, figs. 20-22, 1937.
Smith, Bull. Torrey Bot. Club, vol. 65, p. 561 (part), 1938.
Acer chaneyi Knowlton. MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 61 (part), 1933.

We judge Acer oregonianum to have been a rare maple in the Mascall area, for in our large collections we have discovered only a few samaras and a single leaf to add to the few specimens previously known from this flora. It is also present in small numbers in our collections from the Blue Mountains and the Stinking Water floras.

As originally pointed out by Knowlton, A. oregonianum is closely related to A. macrophyllum Pursh of the Pacific coast. This large maple ranges from southern Alaska southward along the islands and coast of British Columbia, through Washington and Oregon west of the Cascade Mountains, and southward along the Coast Ranges and west Sierra Nevada slopes of California into southern California. Over this wide area it is associated with several diverse forest communities, the North-Coast Coniferous, Sierra-Cascade, Redwood, and Border-Redwood, all of which have many species represented by closely similar fossils in the Miocene floras of eastern Oregon and adjacent areas.

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735, P4129), hypotypes nos. 3192, 3193. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3937, P3936), hypotypes nos. 698, 699, 3194, homeotypes nos. 696, 697. Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotype no. 3195. Trout Creek, Ore.: U. C. M. P. (loc. P275), hypotype no. 604, homeotypes nos. 605, 606, 607. Succor Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P3744). Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotype no. 821, homeotype no. 856. Latah, Wash.: U. S. N. M. (Grand Coulee loc.).

### Acer scottiae MacGinitie

(Plate 41, figures 6-10; plate 42, figure 1)

Acer scottiae MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 62, pl. 12, fig. 4; pl. 11, figs. 4, 8, 1933.
Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 116, 1939.
Smith, Amer. Mid. Naturalist, vol. 25, p. 516, pl. 12, fig. 8 (not fig. 9, which is A. glabroides Brown), 1941.
Aralia ! whitneyi ? Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 16, 1888.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 82, 1902.
Acer oregonianum Knowlton, ibid., p. 75, pl. 13, fig. 6 (not figs. 5, 7, 8, which remain A. oregonianum), 1902.
Acer septilobatum Oliver. Dorf, Carnegie Inst. Wash. Pub. 476, p. 122, pl. 3, fig. 5, 1936.

The affinities of Acer scottiae are clearly with the pictum group of maples, of modern Asian distribution. We have a large number of specimens representing this species in the Mascall collections. They show a considerably greater range of variation than that indicated by the Trout Creek description, so it seems desirable to record the following additional notes on the morphology of the species.

Supplementary description. Leaves up to 15.5 cm. long plus a petiole exceeding 4 cm.; 5- to 7-lobed; base rounded to truncate or broadly cordate; the inner 2 primaries diverging from top of petiole at angles as low as 20°, the second pair at about 40° in leaves with rounded bases; the inner 2 primaries diverging at 40°, the second pair at about 80° in 7-lobed subcordate leaves; sinuses varying from narrow in leaves with rounded bases to broad in subcordate ones.

Discussion. Most of the material is of the general average size of the Trout Creek types, but there is a gradation to larger leaves such as that illustrated on plate 42, figure 1. These larger specimens are closely similar to leaves of the modern Acer amplum Rehder, whereas the others resemble A. pictum Thunberg and its close relatives such as A. cappadocicum Gleditsch, A. cissifolium C. Koch, and A. truncatum Bunge, a closely related phylad extending from Japan westward into the Caucasus. The larger specimens may represent a distinct species, but in view of the complete gradation in size from small to large leaves, and in the base from subcordate and rounded to subacute, we prefer for the present to group all of them into one polymorphic species which includes characters of several modern species of the Platanoidea section of the genus.

Acer scottiae has in recent years been discovered at several Miocene localities in the Columbia Plateau region; these include the Mascall, Blue Mountains, Succor Creek, Stinking Water, Thorn Creek, Trout Creek, and Lower Idaho floras. A closely related species in the Miocene and Pliocene of Eurasia is A. subpictum Saporta, as discussed recently by Hu and Chaney (1938, pp. 61-62).

Occurrence. Mascall, Ore.: U. S. N. M.; U. C. M. P. (locs. P28, P3735), hypotypes nos. O.S. 845, 3212-3217 incl. Blue Mountains, Ore.: U. C. M. P. (loc. P3937), homeotype no. 3219. Stinking Water, Ore.: U. C. M. P. (loc. P4120), hypotype no. 3218. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), holotype no. 613, paratypes nos. 614, 615, 616. Succor Creek, Ore.: U. M. M. P. Lower Idaho, Ida.: U. C. M. P. (loc. P635), hypotype no. 1230. Thorn Creek, Ida.: U. M. M. P.

## Family RHAMNACEAE

### Rhamnus columbiana new species

(Plate 43, figures 1, 2)

Two leaves in the Stinking Water flora and another in the Blue Mountains have all the characters of Rhamnus, and form the basis for the following description.

Description. Leaves elliptic-lanceolate, apex acute and base acute to rounded; leaf 3.5 to 4.5 cm. long, with a stout heavy petiole 1.0 to 1.5 cm. long; midrib firm and straight; 7 to 9 alternate secondaries, diverging from midrib at about 40°, rather straight into outer fourth of blade, where they loop evenly upward along the margin to join the secondaries above; tertiaries irregularly percurrent; finer mesh of irregularly shaped polygons; margin finely and sharply serrate; texture medium.

Discussion. Comparison of such limited fossil material with any one living species of the genus has no great significance, because leaves of a number of the modern species of Rhamnus are much alike. It is nonetheless noteworthy that we can easily duplicate these leaf impressions in the average leaves of Rhamnus californica Eschscholtz, a common California shrub ranging from the redwood forest southward to the desert and reappearing in Arizona and Texas. Rhamnus caroliniana Walter and R. lanceolata Pursh of the eastern United States are two other species having leaves much like R. columbiana. Only a general relationship is apparent with R. purshiana DeCandolle of the humid Pacific coast and northern Rocky Mountains, which has much larger, obovate leaves that are rounded above, as compared with our fossils, which are ovate-lanceolate with acute tips.

Among previously described fossil species, R. columbiana is related to R. precalifornica Axelrod.

This Tehachapi and Mulholland species differs in having an entire margin and rounded tip, and more nearly resembles variants of *R. californica* in the drier parts of its distribution (Axelrod, 1939, 1944b); the Mascall leaves are like those found in the more humid parts of its range. Hannibal has figured a leaf of *R. californica* from the late Pliocene Santa Clara lake beds of the San Francisco Bay region that is similar to *R. columbiana* (1911, p. 338, pl. 15, fig. 7). Though differing from *R. columbiana* in its more oval outline, it is nonetheless referable to the same modern equivalent and probably represents this species rather than *R. precalifornica* Axelrod. *Rhamnus idahoensis* Brown from Salmon is considerably smaller than *R. columbiana* and seems more nearly related to *R. alnifolia* L'Heritier of the northern United States and Canada (Brown, 1935, pl. 69, fig. 13). *Rhamnus quilchenensis* Penhallow from British Columbia apparently represents Rhamnus (Penhallow, 1908, p. 84, fig. 29), but some details are not shown clearly in the drawing. To judge from the sketch, it seems more nearly related to *R. purshiana* than to any other living species. None of the remaining species described from the Upper Cretaceous and Early Tertiary floras of North America seem close to *R. columbiana*. They differ mostly in larger size as well as in important details of shape, margin, and venation; it is apparent that a number of these fossils represent other genera.

*Occurrence*. Stinking Water, Ore.: U. C. M. P. (loc. P4120), holotype no. 3220, homeotype no. 3221. Blue Mountains, Ore.: U. C. M. P. (loc. P3937), paratype no. 3222. Latah, Ida.: U. S. N. M. (east of Moscow loc.).

## Family THEACEAE

### *Gordonia idahoensis* (Knowlton) Berry

(Plate 43, figure 6)

*Gordonia idahoensis* (Knowlton) Berry, U. S. Geol. Surv. Prof. Paper 185, p. 120, 1934.

*Myrica* ? *idahoensis* Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 724, pl. 99, fig. 7, 1898.

*Myrica lanceolata* Knowlton, ibid., p. 724, pl. 99, fig. 5 only, 1898.

*Betula aequalis* ? Lesquereux. Knowlton, ibid., p. 728, pl. 102, fig. 5, 1898.

*Celastrus lacoei* Lesquereux. Berry, U. S. Geol. Surv. Prof. Paper 154, p. 255, 1929.

*Laurus princeps* Heer. Berry, ibid., p. 259, pl. 58, fig. 5, 1929.

*Arbutus trainii* MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 64, pl. 12, fig. 3; pl. 13, figs. 1, 2, 1933.
  Brooks, Ann. Carnegie Mus., vol. 24, p. 300, pl. 21, fig. 5, 1935.
  Oliver, Carnegie Inst. Wash. Pub. 455, p. 26, 1934.

*Arbutus idahoensis* (Knowlton) Brown, U. S. Geol. Surv. Prof. Paper 186, p. 184, pl. 59, figs. 2-4, 1937.
  Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 24, p. 117, 1939.
  Smith, Amer. Mid. Naturalist, vol. 25, p. 519, pl. 14, fig. 4, 1941.

*Arbutus opaca* Smith, ibid., p. 519, pl. 14, fig. 1, 1941.

*Arbutus matthesii* Chaney. Dorf, Carnegie Inst. Wash. Pub. 476, p. 123, pl. 3, fig. 9, 1936.

*Arbutus* sp. Chaney, Carnegie Inst. Wash. Pub. 349, p. 36 (Blue Mts. reference only), 1925.

*Cedrela oregoniana* (Lesquereux). Brown, Jour. Wash. Acad. Sci., vol. 27, p. 513, 1937.

*Cedrela pteraformis* (Berry). Brown, U. S. Geol. Surv. Prof. Paper 186, p. 179, pl. 60, fig. 9 only, 1937.

*Celastrus spokanensis* Berry, U. S. Geol. Surv. Prof. Paper 154, p. 255, pl. 64, fig. 5, 1929.

*Gordonia hesperia*. Berry, Amer. Jour. Sci., 5th ser., vol. 18, p. 430, text figs. 1, 2 only, 1929.
  Berry, U. S. Geol. Surv. Prof. Paper 170, p. 41, pl. 13, figs. 7, 8, 1931.
  Brown, U. S. Geol. Surv. Prof. Paper 186, p. 183, pl. 52, figs. 5, 6 (not figs. 7, 8, which are *Hydrangea knowltoni* [Berry] Chaney and Axelrod), 1937.

*Carpites paulownia* Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 50, pl. 29, fig. 12, 1926.

All the material cited above represents Gordonia, and we believe that it constitutes one species. As discussed by Berry (1929, 1931), the fossil leaves show relationship to both American and Asiatic species, but the characters of the reproductive structures seem to ally the material more nearly with the latter than the former. The leaves are readily matched by such species as *Gordonia lasianthus* (Linnaeus) Ellis (U. C. Herbarium sheets 743950, 108634, 147754) of the Atlantic Coastal Plain, and *G. axillaris* Saysay (U. C. Herbarium sheet 410393) of central and southern China. The chief difference between the modern and the fossil species lies in the reproductive structures. The fossil capsules are essentially intermediate between the nearly sessile capsule of the Asiatic species examined and the long-stalked capsule of the American species; since not all living species have been available for comparison, it is possible that certain other modern Asiatic species are closely similar to the fossil. The seeds of the fossil species are larger than those produced by the modern American species, and in this respect they more nearly resemble the Asiatic species; the oval to ovate fossil capsules are of sufficient size to hold relatively large seeds. Our Blue Mountains collection contains 2 specimens representing internal casts of the valves which compose the capsule. Brown has earlier figured a complete one from this flora as Cedrela (1937a, pl. 64, fig. 5).

The synonymy presented above is thought to be complete. The serrate Latah leaves referred by Brown to *Gordonia hesperia* Berry (Brown, 1937a, pl. 52, fig. 7;

Berry, 1929, pl. 58, fig. 1) differ from Gordonia leaves in having fewer secondaries which loop gently upward along the margin, and a serrate margin; we believe they fall within the variation of Hydrangea and therefore refer them to Hydrangea knowltoni. The leaves formerly assigned to Arbutus idahoensis (Knowlton) Brown are now known to occur with capsules of Gordonia in the Blue Mountains and Latah floras, and in the latter flora seeds also are recorded. These leaves, which cannot be separated from those produced by Gordonia, differ from those of Arbutus in several respects: the teeth are rounded-crenate rather than serrate as is usual in Arbutus; the secondaries are more undulatory and complexly anastomosing and looping in Gordonia than in Arbutus; the secondaries are less numerous than those in Arbutus leaves, and the intersecondaries are not so well developed or so abundant as in madrone; the tertiary mesh is coarse in the fossil leaves and in Gordonia, and fine in Arbutus.

Occurrence. Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotypes nos. 703, 5134. Trout Creek, Ore.: U. M. M. P.; U. C. M. P. (loc. P275), hypotypes nos. 624-627 incl. Succor Creek, Ore.: U. C. M. P. (loc. P3745); U. M. M. P. Lower Idaho, Ida.: U. C. M. P. (loc. P635), hypotype no. 1232. Payette, Ida.: U. S. N. M.; U. C. M. P. (loc. P3743). Thorn Creek, Ida.: U. C. M. P. (loc. P4600). Latah, Wash.: U. S. N. M. (Spokane, Grand Coulee, Whitebird locs.).

## Family CORNACEAE

### Cornus latahense new name

Cornus ovalis Lesquereux. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 183, pl. 63, fig. 5, 1937.

The Latah dogwood figured by Brown differs from the Table Mountain species, Cornus ovalis Lesquereux, in having oval to ovate rather than lanceolate leaves. Brown has pointed out the close relationship between the Latah specimen and leaves of C. nuttallii Audubon, the Pacific dogwood. On the other hand, the specimens of C. ovalis compare better with the leaves of such species as C. californica C. A. Mey of the Pacific slope and C. alternifolia Linnaeus of the eastern United States. The Latah species is thus distinct from C. ovalis, which is now known from the Table Mountain, Mulholland, Dalles, and Bridge Creek floras.

Cornus becki Berry from the Grand Coulee flora has also been compared with C. nuttallii, as well as with its eastern counterpart, C. florida Linnaeus (Berry, 1938, p. 97). A much closer match is found in C. macrophylla Wallich, which ranges widely in eastern Asia from Japan to northern India. Cornus becki differs from C. latahense in that it is larger and has more numerous secondaries, and the secondaries diverge at relatively moderate angles and are nearly subparallel as compared with those of C. latahense, which depart at high angles and are broadly arching.

Occurrence. Latah, Wash.: U. S. N. M. (Spokane loc.)

## Family NYSSACEAE

### Nyssa copeana (Lesquereux) new combination

(Plate 43, figure 8)

Diospyros copeana Lesquereux, Rept. U. S. Geol. Surv. Terr., vol. 7, p. 232, pl. 40, fig. 11, 1878.
Quercus elaenoides Lesquereux, Mem. Harvard Mus. Comp. Zoöl., vol. 6, no. 2, p. 4, pl. 1, fig. 9 (not figs. 10-12, which are Q. convexa Lesquereux), 1878.
Arbutus matthesii Chaney, Carnegie Inst. Wash. Pub. 346, p. 131, pl. 20, figs. 2, 4 only, 1927.
LaMotte, Carnegie Inst. Wash. Pub. 455, pl. 14, figs. 2, 4 (not fig. 1, which is Salix hesperia [Knowlton] Condit, or fig. 3, which is Carya bendirei [Lesquereux] Chaney and Axelrod), 1936.
Nyssa elaenoides (Lesquereux) Condit, Carnegie Inst. Wash. Pub. 553, p. 86, pl. 18, figs. 1, 4; pl. 20, fig. 7, 1944.
Axelrod, Carnegie Inst. Wash. Pub. 553, p. 145, pl. 31, fig. 5, 1944.
Nyssa oregonensis Smith, Bull. Torrey Bot. Club, vol. 65, p. 564, pl. 28, fig. 2, 1938.
Nyssa cf. N. knowltoni Berry. Brooks, Ann. Carnegie Mus., vol. 24, p. 300, pl. 20, fig. 3, 1935.
Cinchonidium copeanum (Lesquereux) Ettingshausen. Knowlton, U. S. Geol. Surv. Bull. 696, p. 167, 1919.

In connection with our revision of the Mascall flora, we have re-examined all collections of Miocene floras from the western United States. In looking over the type Elko collections at the U. S. National Museum we discovered that the specimen described as Diospyros copeana Lesquereux represents a Nyssa of the general sylvatica alliance. Leaves similar to it have recently been identified as Nyssa elaenoides (Lesquereux) Condit in the Table Mountain flora (Condit, 1944b). Since the Elko D. copeana Lesquereux was described earlier than the Table Mountain Quercus elaenoides Lesquereux (see Lesquereux, 1878a, p. 42), we find it necessary to use the specific name copeana rather than elaenoides in accordance with rules of priority. The complete synonymy for Nyssa copeana (Lesquereux) Chaney and Axelrod is given above.

We identify 3 leaves in the Blue Mountains flora as N. copeana. Leaf variation of this species is closely matched by that of the living N. sylvatica Marshall of the eastern United States. These leaves also resemble those of Diospyros virginiana Linnaeus in size, shape, and basic secondary venation. Where the details of venation are preserved, they may readily be distinguished by important differences. The secondaries of Nyssa show marginal loops of moderate size as compared with those of Diospyros, which are conspicuously looped. The mesh of veins in Nyssa is finer than that in Diospyros. The larger tertiaries of Diospyros tend to be percurrent, a character not seen in Nyssa. On the basis of these differences the Blue Mountains fossils seem assignable to Nyssa. Nyssa sylvatica is a widely distributed tree, ranging from Maine westward to Michigan and Missouri and southward into Texas and Florida. Over this wide area its habitats include mountain slopes and the borders of swamps. Judging from the Blue Mountains associates of N. copeana, we consider it to have occupied upland sites, in contrast to N. hesperia, which was largely confined to Taxodium swamps in the Mascall basin.

Occurrence. Blue Mountains, Ore.: U. C. M. P. (loc. P3936), hypotype no. 3226, homeotype no. 3227. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotypes nos. 826, 828, homeotype no. 863. Elko, Nev.: U. S. N. M. Succor Creek, Ore.: U. M. M. P.; Carnegie Mus.

### Nyssa hesperia Berry

(Plate 43, figures 3-5)

Nyssa hesperia Berry, U. S. Geol. Surv. Prof. Paper 170, p. 42, pl. 13, figs. 9-11, 1931.
Brown, Jour. Wash. Acad. Sci., vol. 27, p. 514, 1937 (see synonymy and discussion).
Nyssa knowltoni Berry. Berry, U. S. Geol. Surv. Prof. Paper 185, p. 122, 1934.
MacGinitie, Carnegie Inst. Wash. Pub. 465, p. 150, pl. 12, fig. 3; pl. 14, fig. 3, 1937.
Condit, Carnegie Inst. Wash. Pub. 476, p. 266, pl. 5, fig. 2, 1938.
Phyllites sucosus LaMotte, Carnegie Inst. Wash. Pub. 455, p. 141, pl. 10, figs. 6-8, 1936.
Quercus distincta Lesquereux. LaMotte, ibid., p. 123, pl. 7, figs. 2, 4 (not fig. 3, which is Carya bendirei [Lesquereux] Chaney and Axelrod), 1936.
Ostrya oregoniana Chaney. LaMotte, ibid., p. 118, pl. 9, fig. 3, 1936.
Chionanthus membranaceus Knowlton. Condit, Carnegie Inst. Wash. Pub. 476, p. 267, 1938.

Brown earlier expressed considerable doubt as to whether the leaf described by Berry as Nyssa knowltoni from the Latah actually represents that genus (Brown, 1937b, p. 515), and he has since identified it as a leaflet of Ptelea miocenica Berry (Brown, 1946). For this reason, Brown has transferred all undoubted Nyssa leaves from the Latah flora previously identified as N. knowltoni Berry to N. hesperia, a species based on characteristic seed material. We are adding to his synonymy specimens from the Weaverville, Upper Cedarville, Succor Creek, and Neroly floras that are closely similar to his figured specimens from the Latah (Brown, 1937a, pl. 62, figs. 1-3). All these fossils are markedly like the leaves and fruits of the living N. aquatica Marshall of the southeastern United States.

There are a number of tupelo leaves in the Mascall collections, but seeds are rare except at the Rock Creek (locality P3737) horizon. The Mascall leaves include entire-margined forms as well as those having one or two large teeth. This material is closely matched by leaves and fruits of the modern N. aquatica. In the southeastern United States tupelo is a regular associate of Taxodium in swamps and along the margins of ponds and banks of streams subject to flooding during a good part of the year. A similar habitat is suggested for its Mascall occurrence, where it is also associated with a swamp cypress, Taxodium dubium.

The oldest known record of N. hesperia in the Pacific states is the Middle Oligocene Weaverville flora of northwestern California (MacGinitie) 1937), where Taxodium is one of its commonest associates. It is represented also in the Latah flora with Taxodium, and survived in association with the swamp cypress into the Mio-Pliocene transition in west-central California, where both are recorded in the Neroly flora (Condit, 1938). Nyssa hesperia is in the Succor Creek flora of the Oregon-Idaho boundary, but here Taxodium is replaced by Glyptostrobus, which has generally similar ecological requirements in the sense of a high water table, though it does not inhabit swamps. In the Upper Cedarville flora of northwestern Nevada, N. hesperia is also recorded with Glyptostrobus.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P3737, P4129), hypotypes nos. 3228, 3229, 3231, homeotype no. 3230. Upper Cedarville, Nev.: U. C. M. P. (loc. P97), hypotypes nos. 792, 793, 804, 806, 813, homeotype no. 791. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird locs.). Succor Creek, Ore.: U. C. M. P. (loc. P3745).

## Family HYDROCARYACEAE

### Trapa americana Knowlton

(Plate 42, figure 2)

Trapa americana Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 733, pl. 102, fig. 7a, 1898.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 183, pl. 55, figs. 5, 6, 1937 (see synonymy).
Axelrod, Carnegie Inst. Wash. Pub. 553, p. 204, pl. 39, figs. 1, 4, 1944.

Fruits of Trapa are abundant at locality P4121, in a swamp flora apparently somewhat younger than the Stinking Water flora; they have not been discovered in the Mascall or Blue Mountains assemblages. The great profusion of water chestnut at locality P4121 suggests that it may have largely covered the surface of the lake at the height of the growing season. The only other locality in western North America where we have observed Trapa in comparable abundance is at Coal Valley in western Nevada, where, in association with such aquatics as Nelumbo, Nymphaea, and Polygonum, it also dominates certain horizons.

In view of the wide occurrence of lacustrine deposits in the western United States which are suited to the preservation of fossil plants, it seems strange that Trapa is known from so few localities, for its hard fruits would presumably ensure preservation. At present Trapa is known from the Weaverville, Latah, Stinking Water, Payette, Lower Idaho, and Coal Valley floras, ranging from Middle Oligocene to transitional Mio-Pliocene age, and it survived as late as the Upper Pliocene in the Sonoma flora north of San Francisco Bay (Axelrod, 1944d). Its latest occurrence in North America is in the Citronelle flora of Alabama (Berry, 1916b). The Citronelle has been considered to be of late Pliocene age, but recent evidence suggests it may be early Pleistocene (Fisk, 1945).

Trapa is native to the warmer and temperate parts of the Old World, where it is represented by two or possibly three species. Our fossils show relationship to the fruits produced by the living Trapa natans Linnaeus.

Occurrence. Stinking Water, Ore.: U. C. M. P. (loc. P4121), hypotype no. 3223, homeotypes nos. 3224, 3225. Lower Idaho, Ida.: U. C. M. P. (loc. P636), hypotype no. 1231. Payette, Ida.: U. S. N. M. Latah, Ida.: U. S. N. M. (Potlach Creek loc.).

## Family ERICACEAE

### Vaccinium sophoroides (Knowlton) Brown

(Plate 44, figures 6-8)

Vaccinium sophoroides (Knowlton) Brown, U. S. Geol. Surv. Prof. Paper 186, p. 18, pl. 61, figs. 1-3, 11, 1937 (see synonymy).

Two small leaf impressions in the Blue Mountains flora and one in the Stinking Water flora are referred to this Latah species. These fossils can be duplicated in the large suite of Latah leaves, and they are also closely matched by leaves of the living Vaccinium arboreum (Marshall) Nuttall of the eastern United States. The fossils also resemble V. parvifolium Smith of the Pacific coast, a common member of the coastal forests from central California northward. Another species having leaves like the fossil is the circumboreal V. uliginosum Linnaeus.

Occurrence. Blue Mountains, Ore.: U. C. M. P. (loc. P3936), hypotypes nos. 5135, 5136. Stinking Water, Ore.: U. C. M. P. (loc. P4006), hypotype no. 5137. Latah, Wash.-Ida.: U. S. N. M. (Spokane, Coeur d'Alene locs.).

## Family EBENACEAE

### Diospyros oregoniana (Lesquereux) new combination

(Plate 43, figure 7)

Ficus ? oregoniana Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 18, pl. 9, fig. 3, 1888.
Knowlton, U. S. Geol. Surv. Bull. 204, p. 56, pl. 10, fig. 3, 1902.
Diospyros andersonae Knowlton, U. S. Geol. Surv. Prof. Paper 140, p. 46, pl. 27, fig. 6, 1926.
Brown, U. S. Geol. Surv. Prof. Paper 186, p. 184, pl. 60, figs. 12-17, 21, 1937.

Examination of the types of Ficus ? oregoniana Lesquereux from the Mascall flora shows quite clearly that although this leaf has been somewhat battered in transport, it nonetheless preserves all the diagnostic characters of persimmon. The broadly looping, camptodrome secondaries are those of Diospyros, and the finer nervation when examined under a microscope shows the typical fine mesh of irregularly percurrent veins. Four additional specimens have been collected at the Mascall localities. This material closely resembles leaves of Diospyros virginiana Linnaeus of the eastern United States, and also shows relationship to D. kaki Linnaeus of central and northern China, and Japan.

Persimmon has been recorded at only a few fossil localities in the western United States, and is nowhere abundant. Its known records include the Lower Cedarville, Latah, Mascall, and Succor Creek floras, and it survived into the Lower Pliocene in the Troutdale flora of northwestern Oregon.

Knowlton described and figured a leaf which he named D. elliptica. This specimen shows the characters of Quercus dayana, and is assigned to that species.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P28, P3735), hypotype no. 5138, homeotypes nos. O.S. 884, 5139, 5140. Succor Creek, Ore.: U. C. M. P. (loc. P3745). Latah, Wash.-Ida.: U. S. N. M. (Spokane, Grand Coulee, Whitebird locs.).

## Family OLEACEAE

### Fraxinus coulteri Dorf

(Plate 44, figure 5)

Fraxinus coulteri Dorf, Carnegie Inst. Wash. Pub. 476,

p. 123, pl. 3, figs. 3, 4, 1936.
Fraxinus sp. MacGinitie, Carnegie Inst. Wash. Pub. 416, p. 66, 1933.
Fraxinus sp. fruit Arnold, Contr. Univ. Mich., Mus. Pal., vol. 5, no. 8, p. 97, pl. 3, fig. 3, 1937.

A single samara in the Mascall flora is characterized by a slender shape and a wing that is attached to the upper half of the seed; in these characters it differs fundamentally from Fraxinus dayana Chaney and Axelrod, which is described below as new to the fossil record.

Samaras of F. coulteri are closely similar to those of the living F. oregona Nuttall. This is a common ash distributed along stream banks from northern Washington southward through Oregon to southern California. It lives regularly with the North-Coast Coniferous, Redwood, Sierra-Cascade, and Border-Redwood forests, which have many closely equivalent species in the Mascall and related Miocene floras of Oregon and adjacent areas. Fraxinus coulteri also shows relationship to F. americana Linnaeus, the white ash of the eastern United States and Canada. Fraxinus americana also occurs with many species that have close relatives in the Miocene of western America.

The specimen of Fraxinus reported by MacGinitie from Trout Creek closely resembles the types of F. coulteri and is placed in synonymy under this species; the samara figured by Arnold from Succor Creek represents the same species. Examination of the specimens identified as samaras of F. idahoensis Brown in the Upper Cedarville flora (LaMotte, 1936) shows that they are not ash, but are battered seeds of Cedrela. Fraxinus caudata Dorf from the Pliocene of California (Dorf, 1930) is also similar to the modern F. oregona and may be a descendant of the Miocene F. coulteri; unfortunately, no Pliocene samaras of F. caudata have yet been discovered to confirm the relationship of the Miocene to the Pliocene species. Fraxinus ungeri Lesquereux from the Lower Pliocene of Beaver County, Oklahoma (Chaney and Elias, 1936, pl. 6, figs. 8-10) is generally similar to F. coulteri and to F. caudata in that all three are related to F. americana as well as to F. oregona. Samaras of F. macrophylla Heer from Hansen Island, west Greenland, also seem generally related to F. coulteri (Heer, 1883, vol. 7, pl. 93).

Occurrence. Mascall, Ore.: U. C. M. P. (loc. P28), hypotype no. 5141. Trout Creek, Ore.: U. C. M. P. (loc. P275), homeotype no. 630. Lower Idaho, Ida.: U. M. M. P.; U. C. M. P. (locs. P635, P636, P638), syntypes nos. 1233, 1234. Succor Creek, Ore.: U. M. M. P.

### Fraxinus dayana new species

(Plate 44, figures 1-3)

Fraxinus ? samaras Berry, U. S. Geol. Surv. Prof. Paper 185, p. 122, pl. 24, figs. 3, 4, 1934.

Description. Samaras elliptic-obovate, apex broadly rounded or slightly emarginate, tapering to a cuneate base; 3.5 to 4.5 cm. long, averaging about 4.0 cm., 1.0 to 1.4 cm. wide near middle, averaging about 1.2 cm.; the wing completely enclosing the seed, the body of the seed about one-half the length of the wing; pedicle of samara moderately thin, 5 to 7 mm. long.

Discussion. These samaras resemble those of the modern swamp ash, Fraxinus caroliniana Miller, of the eastern United States. This tree commonly inhabits swamps and the banks of streams subject to flooding during a good part of the year. Among its characteristic associates are Taxodium distichum and Nyssa aquatica, trees whose Miocene equivalents formed an important part of the Mascall forest near sites of deposition.

Among described fossil species of Fraxinus in the western United States, the fragmentary specimens of Fraxinus ? sp. Berry from the Latah (1934, pl. 24, figs. 3, 4) appear to represent macerated samaras of F. dayana. Brown has placed this material in synonymy under F. idahoensis Brown (1935, pl. 67, figs. 14, 18), which differs from F. dayana in being more slender. Fraxinus leptocarya Smith (1941, pl. 12, fig. 2) from Thorn Creek is somewhat like F. dayana but is smaller and the wing does not fully enclose the seed.

Occurrence. Mascall, Ore.: U. C. M. P. (locs. P3735, P3737, P4129, P28, P4123), holotype no. 5142, paratypes nos. 5143, 5144, homeotype no. 5145. Latah, Ida.: U. S. N. M. (Whitebird loc.).

## Family CAPRIFOLIACEAE

### Symphoricarpos salmonensis Brown

Symphoricarpos salmonensis Brown, Jour. Paleontol., vol. 9, p. 583, pl. 69, fig. 7, 1935.
Symphoricarpos elegans (Lesquereux) Smith, Papers Mich. Acad. Sci., Arts and Letters, vol. 23, p. 229, pl. 1, fig. 6, 1938.
Smith, ibid., vol. 24, p. 118, pl. 3, fig. 5, 1939.
Smith, Amer. Mid. Naturalist, vol. 25, p. 520, pl. 13, fig. 2, 1941.

The combination Symphoricarpos elegans (Lesquereux) Smith was based on the Florissant species Celastrinites elegans Lesquereux (1883, pl. 31, fig. 9). MacGinitie (1953, p. 178) has recently shown that C. elegans is so poorly preserved that it cannot be identified, and he has therefore rejected it from the flora; for this reason the new combination presented by Smith cannot be accepted.

Actually, there appears to be no fundamental difference between the fossils from Thorn Creek, Succor Creek, and Lower Idaho which Smith identified as S. elegans and the material described by Brown as S. salmonensis. All these leaves are well matched by those of the living *S. albus* Blake, and also show relationship to leaves of such species as *S. racemosus* Michaux and *S. orbiculatus* Moench. Since there is considerable overlap in variation in leaf shape in these living species, it is not possible to separate them consistently. Thus it seems best to regard the fossil material as one polymorphic species.

*Occurrence.* Salmon, Ida.: U. S. N. M. Succor Creek, Ore.: U. M. M. P. Lower Idaho (Hog Creek loc.), Ida.: U. M. M. P. Thorn Creek, Ida.: U. M. M. P.

### *Viburnum lantanafolium* Berry

(Plate 44, figure 4)

*Viburnum lantanafolium* Berry, U. S. Geol. Surv. Prof. Paper 154, p. 264, pl. 60, fig. 6, 1929.
  Oliver, Carnegie Inst. Wash. Pub. 455, p. 27, pl. 5, figs. 1, 2, 1934.
  Brown, U. S. Geol. Surv. Prof. Paper 186, p. 185, pl. 63, fig. 1, 1937.
*Aesculus hesperia* Berry, U. S. Geol. Surv. Prof. Paper 154, p. 256, pl. 56, fig. 8, 1929.
*Rhamnus idahoensis* Brown, U. S. Geol. Surv. Prof. Paper 186, p. 181, pl. 56, fig. 4, 1937.

*Supplementary description.* Leaves ranging from obtuse to oblanceolate and lanceolate, with acute to obtuse tips and obtuse base; 7 to 11 pairs of alternate to subopposite heavy secondaries, diverging at 35° to 55°, slightly arched upward, conspicuously bifurcating in outer portion to form 2 to 4 prominent abaxial tertiaries which in turn divide to supply the coarse marginal teeth; coarsely percurrent tertiaries slightly arched upward, with the finer mesh forming irregular crossties with the tertiaries; midrib firm, slightly curved or straight; 4 cm. of a medium-thick petiole preserved; margin with closely spaced, heavy teeth; texture medium to subcoriaceous.

*Discussion.* *Viburnum lantanafolium* is represented in the Blue Mountains, but has not yet been discovered in the Mascall or Stinking Water flora. Aside from its Blue Mountains record, it is now known elsewhere in the western United States only from the Latah flora.

Among living members of the genus, *V. lantanafolium* shows relationship to such species as *V. lantana* Linnaeus of southeastern Europe and Asia, and to *V. dilatatum* Thunberg of Japan and *V. pubescens* Wallich of China. The nearest American species are *V. molle* Michaux and *V. venosum* Britton of the eastern United States, but they are not so close to the fossils as the Oriental species mentioned.

*Occurrence.* Blue Mountains, Ore.: U. S. N. M. (Tipton loc.); U. C. M. P. (locs. P3936, P3937), hypotypes nos. 704, 705, 5146. Latah, Wash.: U. S. N. M. (Spokane loc.).

## INCERTAE SEDIS

In the preceding section of the systematic part of this volume we have accounted for 76 of the 95 species described or reported by Lesquereux and Knowlton from the Mascall flora. In the remaining group of 19 there is only 1 plant that we believe may properly be placed under *incertae sedis*; of the others, 5 are regarded as *nomina dubia* and 13 are rejected from the flora for reasons presented below. We include under *incertae sedis* only those plants whose taxonomic position has not yet been established satisfactorily, but which are sufficiently well preserved to give promise of future determination.

In addition to the Mascall species, we are listing under *incertae sedis* a number of fossil plants from other Miocene floras of the Columbia Plateau region. It seems desirable to us to clear all floral lists of plants whose taxonomic status is doubtful, and we believe that by placing them in *incertae sedis* we direct attention to the fact that they have not been properly identified.

### BLUE MOUNTAINS FLORA

Conifer of uncertain affinity Chaney and Axelrod, 1959, p. 144, pl. 14, fig. 9.
Undetermined leaf Brown, 1937a, p. 186, pl. 49, fig. 14.
Undetermined leaf Brown, 1937a, p. 186, pl. 49, fig. 15.
Undetermined leaf Brown, 1937a, p. 186, pl. 57, fig. 5.

### LATAH FLORA

#### Coeur d'Alene Florule

*Carpites boraginoides* Knowlton, 1926, p. 49, pl. 29, fig. 7.
*Lycopodium hesperium* Knowlton, 1926, p. 24, pl. 8, fig. 7.
*Vaccinium salicoides* Knowlton, 1926, p. 46, pl. 28, figs. 9, 9a.
  *Vaccinium americanum* (Lesquereux) Berry. Berry, 1929, p. 262.

#### Grand Coulee Florule

*Carpites boraginoides* Knowlton. Berry, 1931, p. 34.
*Carpites ginkgoides* Knowlton. Berry, 1931, p. 34.
*Carpolithus* sp. Brown.
  *Ficus interglacialis* Hollick. Berry, 1931, p. 37.
  *Phyllites amplexicaulis* Knowlton. Berry, 1931, p. 34.
*Lysichiton washingtonense* Berry, 1931, p. 35, pl. 11, fig. 2.

Tsuga latahensis Berry. Berry, 1931, p. 33.
Viburnum fernquisti Berry. Berry, 1931, p. 34.

### Spokane Florule

Arctostaphylos spatulata Berry, 1929, p. 262, pl. 64, fig. 6.
Carpites boraginoides Knowlton. Brown, 1937a, p. 185.
Carpolithus sp. Brown, 1937a, p. 186, pl. 63, fig. 3.
Carpites menthoides Knowlton, 1926, p. 49, pl. 26, fig. 4.
Berry, 1929, p. 264.
Equisetum underground stem Knowlton, 1926, p. 24, pl. 9, fig. 1; pl. 26, fig. 5; pl. 29, fig. 8.
Malva ? hesperia Knowlton, 1926, p. 24, pl. 9, fig. 1.
Phyllites amplexicaulis Knowlton, 1926, p. 47, pl. 29, fig. 3.
Cercis spokanensis Knowlton, 1926, p. 43, pl. 29, fig. 9.
Brown, 1937a, p. 177, pl. 54, figs. 11, 12.
Cercocarpus praeledifolius Berry, 1929, p. 252, pl. 64, fig. 7.
Brown, 1937a, p. 176, pl. 56, fig. 13.
Diospyros microcalyx Knowlton, 1926, p. 46, pl. 22, figs. 5, 6.
Grass ? Knowlton, 1926, p. 29, pl. 10, figs. 8, 9.
Hicoria juglandiformis (Sternberg) Knowlton. Berry, 1929, p. 241.
Tsuga latahensis Berry, 1929, p. 239, pl. 63, figs. 3, 4.
Umbelliferospermum latahense Berry, 1929, p. 261, pl. 64, figs. 10-12.
Vaccinium americanum (Lesquereux) Berry.
Berry, 1929, p. 262.

### Whitebird Florule

Calyx Berry, 1934, p. 122, pl. 24, fig. 8.
Carpites boraginoides Knowlton.
Carpolithus hibiscoides Brown, 1935, p. 584, pl. 67, fig. 19.
Carpolithus menthoides Knowlton. Berry, 1934, p. 122.
Carpolithus sp. Brown.
Malva ? hesperia Knowlton. Berry, 1934, p. 120, pl. 24, fig. 2.
Cercis spokanensis Knowlton. Brown, 1937a, p. 177, pl. 54, fig. 10.
Cercis idahoensis Berry, 1934, p. 114, pl. 22, figs. 1-3; pl. 23, figs. 5, 6.

## MASCALL FLORA

Berberis (?) gigantea Knowlton, 1902, p. 57, pl. 11, fig. 1.
Chaney and Axelrod, 1959, pl. 44, fig. 9.
Oreopanax gigantea (Knowlton) Arnold. Arnold, 1937, p. 100.

This single incomplete though characteristic leaf is unique in the Mascall flora. It obviously is not Berberis, and though suggestive of certain members of the Araliaceae differs from them sufficiently to indicate that it has no close modern counterpart in that family. Arnold (1937, p. 100) has transferred Berberis (?) gigantea to Oreopanax, but we believe that the resemblances are much too remote to warrant this assignment. Newberry (in Knowlton, 1902, p. 57) thought the fossil might represent a thistle, and if as we believe it represents the distal part of a pinnate leaf, this may well prove to be the case.

## PAYETTE FLORA

Betula fruit Knowlton, 1898, p. 728, pl. 99, fig. 9.
Phyllites obscurus Knowlton, 1898, p. 735, pl. 99, figs. 10, 11.

## SUCCOR CREEK FLORA

Dipteronia insignis Brown. Smith, 1938a, p. 561, pl. 28, fig. 7.
Populus alexanderi Dorf. Smith, 1939b, p. 110.

## THORN CREEK FLORA

Ceanothus sp. Smith, 1941, p. 519, pl. 10, fig. 5.
Pinus sp. Smith, 1941, p. 492, pl. 2, fig. 12.
Prunus chaneyi Condit. Smith, 1941, p. 516.
Rhamnus idahoensis Brown. Smith, 1941, p. 518.
Tilia parvulifolia Smith, 1941, p. 519, pl. 13, fig. 8.

## TROUT CREEK FLORA

Leguminosites sp. MacGinitie, 1933, p. 59, pl. 9, fig. 7.
Lysichiton nevadensis MacGinitie, 1933, p. 48, pl. 7, fig. 4.
Rhododendron ? sp. MacGinitie, 1933, p. 64, pl. 7, fig. 4.
Saussurea ? sp. MacGinitie, 1933, p. 67, pl. 16, fig. 1.
Vincetoxicum ? trinervata MacGinitie, 1933, p. 66, pl. 15, fig. 1.

## UPPER CEDARVILLE FLORA

Acer negundoides MacGinitie. LaMotte, 1936, p. 136, pl. 12, fig. 4 only.
Chamaecyparis gilmoreae LaMotte, 1936, p. 112, pl. 3, fig. 4 only.
Leguminosites vicicarpus LaMotte, 1936, pl. 10, fig. 3.

# NOMINA DUBIA

Many fragmentary fossil plants collected during the early days of geological reconnaissance in the far West were described as the types of species. Some of these fossils cannot be identified generically with any degree of certainty. Others are so incomplete or poorly preserved that features necessary for making specific determination do not appear; thus, although a given fossil may well represent a maple, there may be no way of determining its specific affinity owing to its incompleteness. These scraps which form the types of species are a source of continual annoyance and have entailed much wasted effort in futile attempts at identification for the purpose of determining name priority, or of ascertaining the geological range of a species.

The Mascall flora contains 5 species which were described from material of this sort. In accordance with Article 63 of the Rules of Botanical Nomenclature, which provides that "a name of a taxonomic group must be rejected when its application is uncertain," we regard them as *nomina dubia*. We emphasize that no type should be relegated to this status until the actual specimen has been examined. Careful study of these early types is always necessary because many of the illustrations are incorrect as to details of margin and venation. Furthermore, some of the fossils were not fully cleaned out of the matrix before they were described and figured.

In addition to the 5 Mascall species, we are listing below 3 other plants from the Middle Tertiary floras of the Columbia Plateau region which we also regard as *nomina dubia*.

*Acer dimorphum* Lesquereux, 1888, p. 15, pl. 9, fig. 1.

This may well be a maple of the *macrophyllum* type, but the margin is missing, the specimen is incomplete, and it does not show any diagnostic characters which might serve to distinguish it definitely from certain other maples. There is also a possibility that it might be an aberrant sycamore leaf.

*Crataegus imparilis* Knowlton, 1902, p. 66, pl. 10, fig. 2.

This poorly preserved specimen shows no characters which permit its certain identification. It could well be Crataegus, but it also resembles Ribes as well as certain species of Acer.

*Fagus* ? *bonnevillensis Chaney*, 1920, p. 167, pl. 11, fig. 1.

Examination of this fragmentary Eagle Creek specimen shows clearly that it cannot be allocated definitely to Fagus, as suggested by Brown (1937b, p. 515) and LaMotte (1952, p. 160). The fossil might equally well be referred to Quercus (i.e. *Q. eoprinus* Smith), or possibly to a member of the Betulaceae. Since the margin is largely missing and the specimen is not complete, it cannot be identified with any degree of certainty.

*Phyllites bifurces* Knowlton, 1902, p. 85, pl. 16, fig. 2.

This may represent a leaflet of *Acer minor* Knowlton, but is too poorly preserved to merit a name.

*Phyllites flexuosus* Knowlton, 1898, p. 735, pl. 102, fig. 18.

This scrap from the Payette flora has no characters suitable for generic or specific reference, and should never have been described.

*Quercus horniana* Lesquereux, 1888, p. 17, pl. 5, fig. 6.

Examination of the type shows that the margin is not so well preserved as the illustration tends to indicate. The leaf is suggestive of Ulmus, but the arching secondaries in the basal part of the blade also bring to mind certain leaves of Ostrya. We do not think that the specimen is certainly identifiable. Knowlton (1902, p. 52) has mistakenly reported that the specimen figured by Lesquereux as *Quercus horniana* is not the type of the species. This misconception was due to an error in the assignment of numbers to the types. The leaf figured by Knowlton (1902, pl. 8, fig. 1) as the supposed type of *Q. horniana* is *Zelkova oregoniana* (Knowlton) Brown.

*Rulac orataegifolium* Knowlton, 1902, p. 77, pl. 16, fig. 7.

Both Brown (1937a, p. 180) and MacGinitie (1953, p. 141) have pointed out that *Rulac crataegifolium* may well be a maple of the *Acer negundo* alliance. They have rejected it as a basis for a new combination, however, because it is poorly preserved and fragmentary, a procedure with which we are in full agreement. On the other hand, LaMotte (1952, p. 53) has used it as a basis for a new combination under which he has grouped all material previously referred to *A. negundoides* MacGinitie.

The specimen of *Rulac crataegifolium* is certainly a maple, but there is no assurance that it is a maple of the *negundo* type. It can also be matched, and perhaps better, by leaves of *A. saccharinum*. Since the type is poorly preserved and fragmentary, and since its affinity with other maples cannot be satisfactorily established, we relegate it to *nomen dubium*.

Thuja garmani Lesquereux, 1873, p. 372.

As noted under our discussion of Thuja dimorpha (Oliver) Chaney and Axelrod, the type specimen of T. garmani Lesquereux was never figured and the specimen is lost. Thus it seems best to regard it as a nomen dubium.

## SPECIES REJECTED FROM THE MIOCENE FLORAS OF THE COLUMBIA PLATEAU

Some of the Mascall plants reported by Lesquereux and Knowlton were identified as species occurring in floras elsewhere in the western United States or in Europe. Eight of them were based on scraps which cannot be identified, and we reject them as records of these species in the flora. Six other species recorded by Lesquereux and Knowlton are rejected because they were not figured, the specimens have since been lost, and no plants resembling them have been found in our large collections. Eight other species described from other floras in the region in more recent years are also rejected for reasons presented below.

Acer branches of ? Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 15, 1888.

These are impressions of twigs, but it is not possible to give them a generic reference.

Aralia ! pungens ? Lesquereux, ibid., p. 16, 1888.

This specimen (no. 2428) is not now to be found in the Mascall collections at the U. S. National Museum, so we are rejecting it as a record of this species in the flora. Knowlton (1902, p. 56) noted that the specimen was fragmentary and could not be made out clearly.

Artocarpus californica ? Knowlton, U. S. Geol. Surv. Bull. 204, p. 56, 1902.

The specimens identified by Lesquereux as Aralia ! pungens (Lesquereux, 1888, p. 16) and Myrica (Aralia) lessigii ? Heer (Lesquereux, 1888, p. 16) were placed in synonymy under Artocarpus californica ? Knowlton by Knowlton (1902, p. 56). As noted above, the fragment which forms the basis for the former species is lost. The latter specimen (no. 2522) is a fragment of a large leaf, possibly Platanus. Since it is not generically determinable, we reject it as a record of breadfruit in the Mascall flora.

Berchemia multinervis Al. Braun. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 16, 1888.

Knowlton (1902, p. 87) excluded this species from the flora because the specimen is missing from the collection. We have not encountered any leaves of this characteristic plant in our large collection.

Betula angustifolia Newberry. Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 727, 1898.

This specimen, which was never figured, is not in the type Payette collection at the U. S. National Museum, and is therefore rejected as a record of the species in this flora.

Carpites fragariaeformis n. sp. ? Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 16, 1888.

This specimen was never described or figured, and is not in the collection at the U. S. National Museum.

Carya elaenoides Heer. Lesquereux, ibid., p. 18, 1888.

The specimen (no. 2446) referred to by Lesquereux represents the basal part of a leaf or leaflet which exhibits no characters suitable for generic reference. It may be a leaflet of Carya, but there is no assurance of this because the margin is not well preserved.

Cercocarpus antiquus Lesquereux. Brown, U. S. Geol. Surv. Prof. Paper 186, p. 176, pl. 57, fig. 6, 1937.

We have examined this fragmentary specimen from the Blue Mountains flora together with R. W. Brown and have come to the conclusion that it is not certainly identifiable. It may be a small leaf of Fagus washoensis LaMotte or Quercus eoprinus Smith, both of which are in the flora.

Equisetum sp. Knowlton, U. S. Geol. Surv. Bull. 204, p. 23, pl. 1, fig. 1, 1902.

This is not Equisetum and it does not seem to be determinable; its general characters are suggestive of a calyx.

Hicoria elaenoides (Unger) Knowlton. Knowlton, U. S. Geol. Surv. Bull. 204, p. 38, 1902.

Same as Carya elaenoides Heer, above.

Libocedrus praedecurrens Knowlton. Berry, U. S. Geol. Surv. Prof. Paper 185, p. 104, 1934.

This species is rejected from the Whitebird flora, for there are no specimens representing it in the collections at the U. S. National Museum, and it was not figured.

Myrica (Aralia) lessigii ? Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 16, 1888.

This scrap was considered by Knowlton (1902, p. 56) possibly to represent Artocarpus californica Knowlton. It might be part of a sycamore leaf, but is not determinable.

Odostemon simplex (Newberry) Cockerell. LaMotte, Carnegie Inst. Wash. Pub. 455, p. 126, 1936.

This is possibly a spine of Oreopanax, but is so incomplete that it cannot be determined satisfactorily.

Phyllites payettensis Knowlton. Berry, U. S. Geol. Surv. Prof. Paper 185, p. 122, 1934.

This specimen is missing from the collections in the U. S. National Museum and is therefore rejected as a record of this species in the Lower Idaho flora for lack of evidence.

Pinus sp. Brooks, Ann. Carnegie Mus., vol. 24, p. 281, pl. 4, figs. 1, 4, 5 only, 1935.

These stem fragments cannot be identified with any degree of certainty.

Platanus aspera ? Newberry. Knowlton, U. S. Geol. Surv. 18th Ann. Rept., pt. 3, p. 732, 1898.

This specimen is lost and was not figured.

Populus glandulifera Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 18, 1888.

Knowlton (1902, p. 87) has pointed out that this fragment cannot be identified.

Populus mutabilis Heer. Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 18, 1888.

This broken scrap cannot be identified.

Quercus ? sp. Knowlton, U. S. Geol. Surv. Bull. 204, p. 53, pl. 8, fig. 3, 1902.

This scrap cannot be identified.

Ribes sp. Smith, Amer. Mid. Naturalist, vol. 25, p. 477, 1941.

This specimen has not been described or figured, and has not been found in the Thorn Creek collections.

Salix angusta Al. Braun. Knowlton, U. S. Geol. Surv. Bull. 204, p. 30, 1902.

The specimens cited by Knowlton (nos. 85, 87) are reported to be in the paleobotanical collections at the University of California, but we have not been able to find them. We therefore reject this species from the flora for lack of evidence.

Sapindus angustifolius Lesquereux, Proc. U. S. Nat. Mus., vol. 11, p. 15, 1888.

No venation is visible on this terminal part of a slender leaf, and it is not identifiable.

Sapindus angustifolius ? Lesquereux. Knowlton, U. S. Geol. Surv. Bull. 204, p. 79, 1902.

Same as above.

Sapindus obtusifolius Lesquereux. Knowlton, ibid., p. 79, 1902.

The specimen cited by Knowlton (no. 892) is not present in the collections at the University of California, and we therefore reject the species for lack of evidence.

# SYSTEMATIC REVISIONS

In order to gain a clearer concept of the species in the Mascall and Blue Mountains floras, and to determine their relationships to species in other Miocene floras in the far West, it has been necessary to examine all important collections of Middle and Late Tertiary floras from the western United States. As a result of these investigations, we have made a number of changes in the taxonomic disposition of species in these floras. The revisions are incorporated here together with our current interpretations of previously reported plants from the floras which have been discussed above. In the consolidated list below, the old names are given first, followed by the new name, new combination, or new status (incertae sedis, nomen dubium, or rejected).

The present studies, coupled with those made by Brown (1935 to 1946 inclusive), have materially altered the lists of species in all Miocene floras of the Columbia Plateau and northern Great Basin. Revised lists of species have therefore been presented in our discussions of these floras.

We are especially indebted to Dr. Roland W. Brown for assistance in clearing up a number of citations to Latah species in Berry's publications (1929, 1931, 1934, 1938), as well as for help in studying the large collections of Middle and Late Tertiary floras in the U. S. National Museum. It has been a real pleasure to examine and to study these collections, for it is now possible to locate readily any flora, and to find any previously described species. This is due solely to the painstaking curatorial work carried on by Brown over the past thirty years. The Cenozoic floras in the National Museum are now the best kept and most orderly large paleobotanical collections anywhere in the world.

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*Acer septilobatum* Oliver.
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*Acer* fruits Lesquereux.
Lesquereux, 1888, pl. 6, fig. 2 only; pl. 7, fig. 2
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*Acer* fruits Lesquereux.
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*Acer* fruit Berry.
Berry, 1931, p. 34
= *Acer bolanderi* Lesquereux .... 192
*Acer* sp. samaras Smith.
Smith, 1941, pl. 12, figs. 5, 6
= *Acer bolanderi* Lesquereux .... 192
*Aesculus simulata* Knowlton.
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Oliver, 1934, p. 24
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= *Alnus hollandiana* Jennings .... 159
*Alnus carpinoides* Lesquereux.
Brooks, 1935, p. 284
= *Alnus hollandiana* Jennings .... 159
*Alnus carpinoides* Lesquereux.
LaMotte, 1936, pl. 7, fig. 1
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Brown, 1937a, pl. 48, fig. 4 only
= *Alnus hollandiana* Jennings .... 159
*Alnus carpinoides* Lesquereux.
Brown, 1937a, pl. 48, fig. 5 only
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*Alnus carpinoides* Lesquereux.
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*Alnus corrallina* Lesquereux.
Brown, 1935, pl. 67, fig. 15
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*Alnus corrallina* Lesquereux.
Brown, 1937a, pl. 48, figs. 1-3
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*Alnus corrallina* Lesquereux.
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*Alnus kefersteinii* (Goeppert) Unger.
Lesquereux, 1888, p. 18
= *Betula thor* Knowlton ............ 160
*Alnus kefersteinii* ? (Goeppert) Unger.
Knowlton, 1902, p. 43
= *Betula thor* Knowlton ............ 160
*Alnus microdontoides* Jennings.
Jennings, 1920, pl. 24, fig. 7; pl. 30, figs. 2, 2a
= *Alnus hollandiana* Jennings .... 159
*Alnus prerhombifolia* Berry.
Berry, 1929, pl. 50, fig. 11
= *Alnus hollandiana* Jennings .... 159
*Alnus serrulata fossilis* Newberry.
Newberry, 1898, pl. 46, fig. 6
= *Alnus fossilis* Newberry ........ 157
*Alnus* pistillate cones Knowlton.
Knowlton, 1926, pl. 18, figs. 3-5a.
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*Amelanchier dignatus* (Knowlton) Brown.
Smith, 1938b, p. 228
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*Andromeda* ? (*Leucothoe*) *crassa* Lesquereux.
Lesquereux, 1888, p. 16
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*Andromeda* (?) *crassa* Lesquereux.
Knowlton, 1902, pl. 16, fig. 3
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Lesquereux, 1888, p. 16
= rejected............................ 205
*Aralia* ! *whitneyi* ? Lesquereux.
Lesquereux, 1888, p. 16
= *Acer scottiae* MacGinitie ....... 196
*Aralia whitneyi* ? Lesquereux.
Knowlton, 1902, p. 82
= *Acer scottiae* MacGinitie ....... 196

Only the U. C. M. P. specimen cited by Knowlton (no. 845) is from the Mascall flora; the other (no. 2429) is from Cherry Creek, Oregon.

*Arbutus idahoensis* (Knowlton) Brown.
Brown, 1937a, pl. 59, figs. 2-4
= *Gordonia idahoensis* (Knowlton)
Berry ......................... 197

*Arbutus idahoensis* (Knowlton) Brown.
Smith, 1939b, p. 117
= *Gordonia idahoensis* (Knowlton) Berry .......................... 197

*Arbutus idahoensis* (Knowlton) Brown.
Smith, 1941, pl. 14, fig. 4
= *Gordonia idahoensis* (Knowlton) Berry .......................... 197

*Arbutus matthesii* Chaney.
Chaney, 1927, pl. 20, figs. 2, 4 only
= *Nyssa copeana* (Lesquereux) Chaney and Axelrod ........ 198

*Arbutus matthesii* Chaney.
LaMotte, 1936, pl. 14, fig. 3 only
= *Carya bendirei* (Lesquereux) Chaney and Axelrod ........ 155

*Arbutus matthesii* Chaney.
LaMotte, 1936, pl. 14, figs. 2, 4 only
= *Nyssa copeana* (Lesquereux) Chaney and Axelrod ........ 198

*Arbutus matthesii* Chaney.
LaMotte, 1936, pl. 14, fig. 1 only
= *Salix hesperia* (Knowlton) Condit 153

*Arbutus matthesii* Chaney.
Dorf, 1936, pl. 3, fig. 9
= *Gordonia idahoensis* (Knowlton) Berry .......................... 197

*Arbutus opaca* Smith.
Smith, 1941, pl. 14, fig. 1
= *Gordonia idahoensis* (Knowlton) Berry .......................... 197

*Arbutus trainii* MacGinitie.
MacGinitie, 1933, pl. 12, fig. 3; pl. 13, figs. 1, 2
= *Gordonia idahoensis* (Knowlton) Berry .......................... 197

*Arbutus trainii* MacGinitie.
Brooks, 1935, pl. 21, fig. 5
= *Gordonia idahoensis* (Knowlton) Berry .......................... 197

*Arbutus trainii* MacGinitie.
Oliver, 1934, p. 26
= *Gordonia idahoensis* (Knowlton) Berry .......................... 197

*Arbutus* sp. Chaney.
Chaney, 1925b, p. 36 (Blue Mts. reference only)
= *Gordonia idahoensis* (Knowlton) Berry .......................... 197

*Arctostaphylos spatulata* Berry.
Berry, 1929, pl. 64, fig. 6
= *incertae sedis* ..................... 203

*Artocarpus californica* ? Knowlton.
Knowlton, 1902, p. 56
= rejected ............................ 205

*Berberis* (?) *gigantea* Knowlton.
Knowlton, 1902, pl. 11, fig. 1
= *incertae sedis* ..................... 203

*Berchemia multinervis* Al. Braun.
Lesquereux, 1888, p. 16
= rejected ............................ 205

*Betula aequalis* ? Lesquereux.
Knowlton, 1898, pl. 102, fig. 5
= *Gordonia idahoensis* (Knowlton) Berry .......................... 197

*Betula angustifolia* Newberry.
Knowlton, 1898, p. 727
= rejected ............................ 205

*Betula bendirei* Knowlton.
Smith, 1938a, pl. 29, fig. 3
= *Amelanchier couleeana* (Berry) Brown ......................... 183

*Betula* ? *dayana* Knowlton.
Knowlton, 1902, pl. 4, fig. 4
= *Ulmus speciosa* Newberry...... 174

*Betula heteromorpha* Knowlton.
Berry, 1931, p. 34
= *Betula fairii* Knowlton ........... 160

*Betula heteromorpha* Knowlton.
Berry, 1934, p. 107 (part)
= *Alnus relatus* (Knowlton) Brown 159

*Betula heteromorpha* Knowlton.
Berry, 1934, p. 107 (part)
= *Betula fairii* Knowlton ........... 160

*Betula heteromorpha* Knowlton.
Brooks, 1935, pl. 5, fig. 1 only
= *Gymnocladus dayana* (Knowlton) Chaney and Axelrod ........ 187

*Betula heteromorpha* Knowlton.
Brooks, 1935, pl. 5, fig. 2 only
= *Alnus relatus* (Knowlton) Brown 159

*Betula heteromorpha* Knowlton.
Brooks, 1935, pl. 5, fig. 3 only
= *Quercus dayana* Knowlton....... 165

*Betula idahoensis* Smith.
Smith, 1941, pl. 10, fig. 4
= *Betula vera* Brown .............. 161

*Betula lacustris* MacGinitie.
MacGinitie, 1933, pl. 4, fig. 2 only
= *Alnus hollandiana* Jennings .... 159

*Betula lacustris* MacGinitie.
MacGinitie, 1933, pl. 4, figs. 3, 4 only
= *Betula thor* Knowlton ............ 160

*Betula lacustris* MacGinitie.
Dorf, 1936, pl. 1, fig. 5
= *Betula thor* Knowlton ............ 160

*Betula lacustris* MacGinitie.
Smith, 1941, pl. 6, fig. 6
= *Betula thor* Knowlton ............ 160

*Betula largei* Knowlton.
Berry, 1931, p. 34
= *Betula fairii* Knowlton ........... 160

*Betula* sp. Oliver.
Oliver, 1934, pl. 3, fig. 5
= *Betula fairii* Knowlton ........... 160

*Betula* sp. Oliver.
Oliver, 1934, p. 18 (part)
= *Crataegus gracilens* MacGinitie 184

*Betula* fruit Knowlton.
Knowlton, 1898, pl. 99, fig. 9
= *incertae sedis* ..................... 203

*Carpinus grandis* Unger.
Lesquereux, 1888, p. 18
= *Alnus relatus* (Knowlton) Brown 159

*Carpinus grandis* ? Unger.
Knowlton, 1902, p. 38 (part)
= *Ostrya oregoniana* Chaney...... 162

Carpinus grandis ? Unger.
Knowlton, 1902, p. 38 (part)
= Alnus relatus (Knowlton) Brown 159

Carpinus grandis Unger.
Chaney, 1927, pl. 9, figs. 6, 10, 11 only
= Carpinus payettensis Smith .... 162

Carpinus grandis Unger.
MacGinitie, 1933, p. 50
= Carpinus payettensis Smith .... 162

Carpinus grandis Unger.
Axelrod, 1944f, pl. 43, fig. 6
= Carpinus payettensis Smith .... 162

Carpinus pyramidalis Heer.
Lesquereux, 1888, p. 18
= Ostrya oregoniana Chaney ..... 162

Carpinus sp. Knowlton.
Knowlton, 1926, p. 35
= Alnus relatus (Knowlton) Brown 159

Carpites fragariaeformis Lesquereux
Lesquereux, 1888, p. 16
= rejected ............................ 205

Carpites paulownia Knowlton.
Knowlton, 1926, pl. 29, fig. 12
= Gordonia idahoensis (Knowlton)
Berry .......................... 197

Carya egregia (Lesquereux) LaMotte.
LaMotte, 1936, pl. 4, figs. 5, 6; pl. 6, figs. 1, 2
= Carya bendirei (Lesquereux)
Chaney and Axelrod ........ 155

Carya egregia (Lesquereux) LaMotte.
Brown, 1937a, pl. 47, fig. 4
= Pterocarya mixta (Knowlton)
Brown ......................... 157

Carya egregia (Lesquereux) LaMotte.
Brown, 1937a, pl. 57, fig. 4
= Carya bendirei (Lesquereux)
Chaney and Axelrod ........ 155

Carya egregia (Lesquereux) LaMotte.
Smith, 1939b, pl. 7, fig. 1
= Pterocarya mixta (Knowlton)
Brown ......................... 157

Carya egregia (Lesquereux) LaMotte.
Smith, 1941, pl. 5, fig. 3
= Carya bendirei (Lesquereux)
Chaney and Axelrod......... 155

Carya elaenoides Heer.
Lesquereux, 1888, p. 18
= rejected ............................ 205

Carya simulata (Knowlton) Brown.
Brown, 1937a, p. 169
= Carya bendirei (Lesquereux)
Chaney and Axelrod ........ 155

Cassia obtusa Knowlton.
Knowlton, 1898, pl. 100, fig. 4 only
= Quercus simulata Knowlton .... 171

Cassia phaseolites ? Unger.
Lesquereux, 1888, p. 16
= Carya bendirei (Lesquereux)
Chaney and Axelrod ........ 155

Castanea atavia Unger.
Lesquereux, 1883, p. 52, fig. 2
= Zelkova oregoniana (Knowlton)
Brown ......................... 174

Castanea castaneaefolia (Unger) Knowlton.
Knowlton, 1926, pl. 18, figs. 7, 8; pl. 19, fig. 1
= Castanea spokanensis
(Knowlton) Chaney and
Axelrod ....................... 162

Castanea castaneaefolia (Unger) Knowlton.
Berry, 1931, p. 34
= Castanea spokanensis
(Knowlton) Chaney and
Axelrod)....................... 162

Castanea castaneaefolia (Unger) Knowlton.
Berry, 1934, p. 108
= Castanea spokanensis
(Knowlton) Chaney and
Axelrod ....................... 162

Castanea orientalis Chaney.
Berry, 1929, pl. 51, figs. 4, 5
= Castanea spokanensis
(Knowlton) Chaney and
Axelrod ....................... 162

Castanea orientalis Chaney.
Brown, 1937a, pl. 49, fig. 17
= Castanea spokanensis
(Knowlton) Chaney and
Axelrod ....................... 162

Castanea orientalis Chaney.
Berry, 1938, p. 89
= Quercus simulata Knowlton .... 171

Castanopsis angustifolia Smith.
Smith, 1941, pl. 6, figs. 1, 2, 4
= Quercus simulata Knowlton .... 171

Castanopsis chrysophylloides Lesquereux.
LaMotte, 1936, p. 121
= Quercus simulata Knowlton .... 171

Castanopsis consimilis (Newberry) Brooks.
Brooks, 1935, pl. 17, fig. 1
= Quercus dayana Knowlton ...... 165

Castanopsis consimilis (Newberry) Brooks.
Brooks, 1935, pl. 7, figs. 3, 4; pl. 8, figs. 1-5;
pl. 9, figs. 4, 5; pl. 10, figs. 4, 6; pl. 20,
fig. 5
= Quercus simulata Knowlton .... 171

Castanopsis consimilis (Newberry) Brooks.
Brooks, 1935, pl. 6, fig. 2
= Quercus eoprinus Smith......... 167

Castanopsis consimilis (Newberry) Brooks.
Berry, 1938, fig. 6
= Quercus simulata Knowlton .... 171

Castanopsis convexa (Lesquereux) Brooks.
Brooks, 1935, pl. 6, fig. 5; pl. 10, figs. 1, 3;
pl. 12, figs. 1-6; pl. 13, figs. 4-6; pl. 18,
figs. 3-5; pl. 20, fig. 4
= Quercus dayana Knowlton....... 165

Castanopsis convexa (Lesquereux) Brooks.
Brooks, 1935, pl. 21, fig. 1b
= Quercus simulata Knowlton .... 171

Castanopsis convexa (Lesquereux) Brooks.
Dorf, 1936, pl. 1, figs. 7, 8
= Quercus hannibali Dorf.......... 168

Castanopsis convexa (Lesquereux) Brooks.
Brown, 1937a, pl. 49, figs. 8-11
= Quercus dayana Knowlton ...... 165

Castanopsis convexa (Lesquereux) Brooks.
Smith, 1939b, pl. 2, fig. 7; pl. 5, fig. 7
= Quercus dayana Knowlton ...... 165

Castanopsis perplexa (Knowlton) Brown.
Brown, 1940, p. 348 (reference to Salix perplexa Knowlton)
= Quercus dayana Knowlton ...... 165

Ceanothus sp. Smith.
Smith, 1941, pl. 10, fig. 5
= incertae sedis .................... 203

Cedrela browniana Arnold.
Arnold, 1936b, fig. 11
= Cedrela trainii Arnold .......... 189

Cedrela browniana Arnold.
Arnold, 1937, pl. 7, figs. 1, 2
= Cedrela trainii Arnold .......... 189

Cedrela oregoniana (Lesquereux) Brown.
Brown, 1937b, p. 513
= Gordonia idahoensis (Knowlton) Berry .......................... 197

Cedrela oregoniana (Lesquereux) Brown.
Smith, 1939b, pl. 3, fig. 7 only
= Quercus hannibali Dorf ......... 168

Cedrela pteraformis (Berry) Brown.
Brown, 1937a, pl. 60, fig. 9 only
= Gordonia idahoensis (Knowlton) Berry .......................... 197

Cedrela pteraformis (Berry) Brown.
Arnold, 1937, pl. 6, figs. 4, 7-10
= Cedrela trainii Arnold .......... 189

Cedrela ? pteraformis (Berry) Brown.
Smith, 1941, pl. 14, fig. 2
= Quercus hannibali Dorf ......... 168

Cedrela sp. capsule Arnold.
Arnold, 1936b, fig. 3
= Cedrela trainii Arnold .......... 189

Cedrela sp. seeds Arnold.
Arnold, 1936b, figs. 4-10
= Cedrela trainii Arnold .......... 189

Celastrus confluens Knowlton.
Knowlton, 1902, pl. 12, figs. 1-3
= Carya bendirei (Lesquereux) Chaney and Axelrod ........ 155

Celastrus dignatus Knowlton.
Knowlton, 1902, pl. 11, fig. 5
= Zelkova oregoniana (Knowlton) Brown .......................... 174

Celastrus lacoei Lesquereux.
Berry, 1929, p. 255
= Gordonia idahoensis (Knowlton) Berry ........................... 197

Celastrus spokanensis Berry.
Berry, 1929, pl. 64, fig. 5
= Gordonia idahoensis (Knowlton) Berry .......................... 197

Celastrus sp. Dorf.
Dorf, 1936, pl. 3, fig. 7
= Hydrangea bendirei (Ward) Knowlton ....................... 180

Cercis idahoensis Berry.
Berry, 1934, pl. 22, figs. 1-3; pl. 23, figs, 5, 6
= Cercis spokanensis Knowlton
= incertae sedis .................... 203

Cercis spokanensis Knowlton.
Knowlton, 1926, pl. 29, fig. 9
= incertae sedis .................... 203

Cercis spokanensis Knowlton.
LaMotte, 1936, pl. 10, fig. 4
= Cercis washoensis Chaney and Axelrod ....................... 187

Cercis spokanensis Knowlton.
Brown, 1937a, pl. 54, figs. 10-12 (and all seed pods listed in synonymy, but not the leaves, which are Exbucklandia oregonensis [Chaney] Brown)
= incertae sedis .................... 203

Cercocarpus antiquus Lesquereux.
Oliver, 1934, p. 22
= Quercus eoprinus Smith ......... 167

Cercocarpus antiquus Lesquereux.
Dorf, 1936, p. 118
= Quercus eoprinus Smith ........ 167

Cercocarpus antiquus Lesquereux.
Brown, 1937a, pl. 57, fig. 6
= rejected ............................. 205

Cercocarpus cuneatus Dorf.
Smith, 1941, pl. 12, fig. 1
= Holodiscus idahoensis Chaney and Axelrod .................. 185

Cercocarpus harneyensis Arnold.
Arnold, 1937, pl. 4, fig. 3
= Holodiscus harneyensis (Arnold) Axelrod ............ 184

Cercocarpus praeledifolius Berry.
Berry, 1929, pl. 64, fig. 7
= incertae sedis .................... 203

Cercocarpus praeledifolius Berry.
Brown, 1937a, pl. 56, fig. 13
= incertae sedis .................... 203

Chamaecyparis gilmoreae LaMotte.
LaMotte, 1936, pl. 3, fig. 4 only
= incertae sedis .................... 203

Chamaecyparis gilmoreae LaMotte.
LaMotte, 1936, pl. 3, fig. 5 only
= Thuja dimorpha (Oliver) Chaney and Axelrod .................. 148

Chamaecyparis gracilis Condit.
Condit, 1944a, pl. 4, fig. 2
= Chamaecyparis linguaefolia (Lesquereux) MacGinitie .. 146

Chamaecyparis gracilis Condit.
Chaney, 1944c, pl. 57, fig. 3
= Chamaecyparis linguaefolia (Lesquereux) MacGinitie .. 146

Chionanthus membranaceus Knowlton.
Condit, 1938, p. 267
= Nyssa hesperia Berry .......... 199

Cinchonidium copeanum (Lesquereux) Ettingshausen.
Knowlton, 1919, p. 167
= Nyssa copeana (Lesquereux) Chaney and Axelrod ....... 198

Cornus ovalis Lesquereux.
Brown, 1937a, pl. 63, fig. 5
= Cornus latahense Chaney and Axelrod ....................... 198

Corylus macquarrii (Forbes) Heer.
Oliver, 1934, pl. 3, figs. 2, 4
= Alnus harneyana Chaney and Axelrod ........................ 158

Corylus macquarrii (Forbes) Heer.
Oliver, 1934, p. 23 (part)
= Crataegus gracilens MacGinitie 184

Corylus macquarrii (Forbes) Heer.
Brown, 1937a, pl. 50, fig. 6
= Crataegus gracilens MacGinitie 184

Crataegus gracilens MacGinitie.
Oliver, 1934, p. 23
= Alnus harneyana Chaney and Axelrod ........................ 158

Crataegus heterodentata Chaney.
Chaney, 1920, pl. 17, figs. 1, 2
= Acer minor Knowlton ............ 194

Crataegus imparilis Knowlton.
Knowlton, 1902, pl. 10, fig. 2
= nomen dubium ..................... 204

Crataegus newberryi Cockerell.
LaMotte, 1936, p. 131
= Crataegus pacifica Chaney ..... 184

Crataegus newberryi Cockerell.
Condit, 1944a, pl. 11, figs. 1-3
= Crataegus pacifica Chaney ..... 184

Crataegus newberryi Cockerell.
Condit, 1944b, pl. 16, fig. 1
= Crataegus pacifica Chaney ..... 184

Cyperacites sp. Knowlton.
Knowlton, 1902, pl. 1, fig. 9
= Typha lesquereuxi Cockerell .. 149

Diospyros andersonae Knowlton.
Knowlton, 1926, pl. 27, fig. 6
= Diospyros oregoniana (Lesquereux) Chaney and Axelrod 200

Diospyros andersonae Knowlton.
Brown, 1937a, pl. 60, figs. 12-17, 21
= Diospyros oregoniana (Lesquereux) Chaney and Axelrod 200

Diospyros copeana Lesquereux.
Lesquereux, 1878b, pl. 40, fig. 11
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Berry, 1934, p. 117
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Knowlton, 1902, p. 43
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Ficus ? oregoniana Lesquereux.
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Fraxinus ? samaras Berry.
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Gordonia hesperia Berry.
Berry, 1931, pl. 13, figs. 7, 8
= Gordonia idahoensis (Knowlton)
Berry .......................... 197

Gordonia hesperia Berry.
Brown, 1937a, pl. 52, figs. 5, 6 only
= Gordonia idahoensis (Knowlton)
Berry .......................... 197

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Brown, 1937a, pl. 52, figs. 7, 8 only
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Gymnocladus casei Berry.
Berry, 1919, pl. 94, fig. 2
= Gymnocladus dayana (Knowlton)
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Gymnocladus casei Berry.
Chaney and Elias, 1936, pl. 6, fig. 7
= Gymnocladus dayana (Knowlton)
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Knowlton, 1902, p. 38
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Hicoria juglandiformis (Sternberg) Knowlton.
Berry, 1929, p. 241
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Hollick, 1927, pl. 30, figs. 1, 2
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Berry, 1929, pl. 52, fig. 7
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Hydrangea bendirei (Ward) Knowlton.
Brown, 1937a, pl. 53, figs. 1, 2
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Juglans hesperia Knowlton.
Dorf, 1936, p. 110 (part)
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Lesquereux, 1878a, pl. 9, fig. 10
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Juglans oregoniana Lesquereux.
Knowlton, 1902, p. 36
= Pterocarya mixta (Knowlton)
Brown .......................... 157

Juglans oregoniana Lesquereux.
MacGinitie, 1933, p. 50
= Juglans browniana Chaney and
Axelrod ........................ 156

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Oliver, 1934, p. 18
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Lesquereux, 1883, pl. 57, fig. 3; pl. 58, figs. 6-8
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Berry, 1929, pl. 58, fig. 5
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Condit, 1938, pl. 7, figs. 1, 2
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LaMotte, 1936, pl. 10, fig. 3
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MacGinitie, 1933, pl. 9, fig. 7
= incertae sedis ..................... 203

*Leguminosites* sp. Dorf.
Dorf, 1936, pl. 3, fig. 1
= *Cercis washoensis* Chaney and Axelrod .................. 187

*Libocedrus decurrens* Torrey.
Mason, 1927, pl. 5, figs. 3, 7, 9-11
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*Libocedrus praedecurrens* Knowlton.
Knowlton, 1926, pl. 8, fig. 8
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*Libocedrus praedecurrens* Knowlton.
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= *Fokienia praedecurrens* (Knowlton) Chaney and Axelrod... 147

*Libocedrus praedecurrens* Knowlton.
Berry, 1934, p. 104
= rejected ............................ 206

*Libocedrus* sp. Dorf.
Dorf, 1930, pl. 6, fig. 8
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*Libocedrus* sp. Dorf.
Dorf, 1936, pl. 1, fig. 4
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*Liquidambar acutilobum* Chaney.
Chaney, 1920, pl. 15, fig. 4
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*Liquidambar californicum* Lesquereux.
Chaney, 1920, p. 174
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar californicum* Lesquereux.
Berry, 1929, p. 250
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar californicum* Lesquereux.
Oliver, 1934, p. 21
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar californicum* Lesquereux.
Berry, 1934, p. 113
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar californicum* Lesquereux.
Brown, 1937a, pl. 61, figs. 9, 10
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar californicum* Lesquereux.
Berry, 1938, fig. 3
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*Liquidambar europaeum* Al. Braun.
Lesquereux, 1888, p. 14
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar europaeum* Al. Braun.
Newberry, 1898, pl. 47, figs. 1-3
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar europaeum* Al. Braun.
Knowlton, 1902, p. 62
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar europaeum* Al. Braun.
Chaney, 1920, p. 174
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar europaeum patulum* Knowlton.
Knowlton, 1902, pl. 10, fig. 5
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar protensum* Unger.
Lesquereux, 1888, pl. 8, fig. 3
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar* sp. ? Knowlton.
Knowlton, 1902, pl. 12, fig. 4
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar* fruit Berry.
Berry, 1931, pl. 38
= *Liquidambar pachyphyllum* Knowlton ...................... 181

*Liquidambar* fruit Berry.
Berry, 1934, p. 114
= *Liquidambar pachyphyllum* Knowlton ...................... 181

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*Lycopodium prominens* Lesquereux.
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= *Taxodium dubium* (Sternberg) Heer ........................... 146

*Lycopodium prominens* Lesquereux.
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*Lysichiton nevadensis* MacGinitie.
MacGinitie, 1933, pl. 7, fig. 4
= *incertae sedis* ..................... 203

*Lysichiton washingtonense* Berry.
Berry, 1931, pl. 11, fig. 2
= *incertae sedis* ..................... 202

*Magnolia californica* Lesquereux.
Lesquereux, 1878a, pl. 6, fig. 5 only
= *Persea pseudocarolinensis* Lesquereux .................. 177

*Magnolia californica* Lesquereux.
Condit, 1938, p. 260 (part)
= *Persea pseudocarolinensis* Lesquereux .................. 177

*Magnolia californica* Lesquereux.
Condit, 1938, p. 260 (part)
= *Magnolia corrallina* Chaney and Axelrod .................. 175

Magnolia californica Lesquereux.
Condit, 1944b, pl. 16, fig. 4
= Persea pseudocarolinensis Lesquereux .................. 177

Magnolia ingelfieldi Heer.
Lesquereux, 1888, p. 13
= Platanus dissecta Lesquereux.. 182

Magnolia ingelfieldi Heer.
Knowlton, 1902, p. 59
= Platanus dissecta Lesquereux. 182

Magnolia ingelfieldi Heer.
Berry, 1938, p. 94
= Nyssa hesperia Berry ........... 199

Magnolia lanceolata Lesquereux.
Lesquereux, 1888, p. 13
= Carya bendirei (Lesquereux) Chaney and Axelrod ........ 155

Magnolia oregonensis Chaney.
Smith, 1941, pl. 14, fig. 5
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Mahonia reticulata (MacGinitie) Brown.
Brown, 1937a, pl. 52, fig. 4
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Meibomites cf. M. lucens Knowlton.
Brooks, 1935, pl. 19, figs. 1-3
= Gymnocladus dayana (Knowlton) Chaney and Axelrod ........ 187

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Myrica lanceolata Knowlton.
Knowlton, 1898, pl. 99, fig. 5 only
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Myrica (Aralia) lessigii ? Heer.
Lesquereux, 1888, p. 16
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Nyssa elaenoides (Lesquereux) Condit.
Condit, 1944b, pl. 18, figs. 1, 4; pl. 20, fig. 7
= Nyssa copeana (Lesquereux) Chaney and Axelrod ........ 198

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Axelrod, 1944b, pl. 31, fig. 5
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Nyssa knowltoni Berry.
Berry, 1934, p. 122
= Nyssa hesperia Berry ........... 199

Nyssa knowltoni Berry.
Arnold, 1937, pl. 8, figs. 1, 5
= Ptelea miocenica Berry ........ 188

Nyssa knowltoni Berry.
MacGinitie, 1937, pl. 12, fig. 3; pl. 14, fig. 3
= Nyssa hesperia Berry ........... 199

Nyssa knowltoni Berry.
Condit, 1938, pl. 5, fig. 2
= Nyssa hesperia Berry ........... 199

Nyssa cf. N. knowltoni Berry.
Brooks, 1935, pl. 20, fig. 3
= Nyssa copeana (Lesquereux) Chaney and Axelrod ........ 198

Nyssa oregonensis Smith.
Smith, 1938a, pl. 28, fig. 2
= Nyssa copeana (Lesquereux) Chaney and Axelrod ........ 198

Odostemon simplex (Newberry) Cockerell.
Berry, 1934, pl. 23, fig. 1 only
= Mahonia reticulata (MacGinitie) Brown .......................... 176

Odostemon simplex (Newberry) Cockerell.
Berry, 1934, pl. 23, fig. 2 only
= Quercus hannibali Dorf ......... 168

Odostemon simplex (Newberry) Cockerell.
LaMotte, 1936, p. 126
= rejected ............................ 206

Odostemon simplex (Newberry) Cockerell.
Dorf, 1936, p. 118
= Mahonia reticulata (MacGinitie) Brown .......................... 176

Oreopanax gigantea (Knowlton) Arnold.
Arnold, 1937, p. 100
= Berberis ? gigantea Knowlton
= incertae sedis ............ 203

Ostrya oregoniana Chaney.
LaMotte, 1936, pl. 9, fig. 3
= Nyssa hesperia Berry ........... 199

Ostrya oregoniana Chaney.
Berry, 1934, pl.107
= Fagus washoensis LaMotte .... 164

Persea miocenica Arnold.
Arnold, 1937, pl. 2, fig. 2
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Condit, 1938, pl. 7, figs. 1, 2
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Philadelphus bendirei (Knowlton) Chaney.
Oliver, 1934, p. 21
= Sassafras columbiana Chaney and Axelrod .................. 179

Philadelphus bendirei (Knowlton) Chaney.
Arnold, 1937, pl. 3, fig. 4
= Sassafras columbiana Chaney and Axelrod .................. 179

Phragmites oeningensis Al. Braun.
Lesquereux, 1888, p. 19
= Typha lesquereuxi Cockerell .. 149

Phragmites oeningensis Al. Braun.
Knowlton, 1902, p. 27
= Typha lesquereuxi Cockerell .. 149

Phyllites bifurces Knowlton.
Knowlton, 1902, pl. 16, fig. 2
= nomen dubium .................... 204

Phyllites cladrastifolia Arnold.
Arnold, 1937, pl. 8, fig. 2
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Knowlton, 1898, pl. 102, fig. 18
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Phyllites inexpectans Knowlton.
Knowlton, 1902, pl. 16, fig. 6
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*Phyllites mascallensis* Arnold.
Arnold, 1937, p. 100 (part)
= *Lindera oregoniana* (Knowlton)
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*Phyllites obscurus* Knowlton.
Knowlton, 1898, pl. 99, figs. 10, 11
= *incertae sedis* ..................... 203

*Phyllites oregonianus* Knowlton.
MacGinitie, 1933, pl. 7, fig. 2
= *Lindera oregoniana* (Knowlton)
Chaney and Axelrod ........ 177

*Phyllites sucosus* LaMotte.
LaMotte, 1936, pl. 10, figs. 6-8
= *Nyssa hesperia* Berry ........... 199

*Phyllites* sp. Knowlton.
Knowlton, 1923, pl. 43, figs. 13, 15
= *Holodiscus idahoensis* Chaney
and Axelrod .................. 185

*Picea lahontense* MacGinitie.
Dorf, 1936, pl. 1, fig. 2
= *Picea sonomensis* Axelrod ..... 141

*Picea* sp. Mason.
Mason, 1927, pl. 3, fig. 2
= *Picea lahontense* MacGinitie .. 140

*Picea* sp. Mason.
Oliver, 1934, p. 13
= *Picea sonomensis* Axelrod ..... 141

*Picea* sp. Brown.
Brown, 1937a, pl. 45, fig. 18 only
= *Picea sonomensis* Axelrod ..... 141

*Picea* sp. Brown.
Brown, 1937a, pl. 45, fig. 19 only
= *Picea lahontense* MacGinitie .. 140

*Picea* cones Brown.
Brown, 1937a, pl. 45, figs. 29, 30
= *Tsuga sonomensis* Axelrod .... 144

*Pinus knowltoni* Chaney.
Mason, 1927, pl. 3, figs. 6, 7
= *Pinus tiptoniana* Chaney and
Axelrod ....................... 142

*Pinus knowltoni* Chaney.
MacGinitie, 1933, p. 46
= *Pinus harneyana* Chaney and
Axelrod ....................... 141

*Pinus knowltoni* Chaney.
Dorf, 1936, p. 106
= *Pinus wheeleri* Cockerell ...... 143

*Pinus knowltoni* Chaney.
Smith, 1939b, pl. 7, fig. 3
= *Pinus harneyana* Chaney and
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*Pinus knowltoni* Chaney.
Oliver, 1934, p. 13
= *Pinus tiptoniana* Chaney and
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*Pinus latahensis* Berry.
Berry, 1929, pl. 49, fig. 7
= *Pinus wheeleri* Cockerell ...... 143

*Pinus monticolensis* Berry.
Berry, 1929, pl. 49, figs. 5, 8
= *Pinus wheeleri* Cockerell ...... 143

*Pinus monticolensis* Berry.
Berry, 1934, p. 104
= *Pinus wheeleri* Cockerell ....... 143
This specimen is from Spokane, Washington, not Whitebird, Idaho.

*Pinus monticolensis* Berry.
LaMotte, 1936, pl. 5, figs. 1, 4
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*Pinus quinifolia* Smith.
Smith, 1941, pl. 2, figs. 2, 8
= *Pinus wheeleri* Cockerell ....... 143

*Pinus russelli* LaMotte.
LaMotte, 1936, pl. 5, figs. 2, 3
= *Pinus wheeleri* Cockerell ...... 143

*Pinus steenstrupiana* Heer.
Penhallow, 1908, text figs. 20, 21 only
= *Abies toxirivus* Chaney and
Axelrod ....................... 139

*Pinus tetrafolia* Berry.
Berry, 1929, pl. 49, fig. 6
= *Pinus wheeleri* Cockerell ...... 143

*Pinus tetrafolia* Berry.
Dorf, 1936, p. 106
= *Pinus wheeleri* Cockerell ...... 143

*Pinus trunculus* Dawson.
Penhallow, 1908, text fig. 24
= *Pinus wheeleri* Cockerell ...... 143

*Pinus tulameenensis* Penhallow.
Penhallow, 1908, text fig. 34
= *Pinus wheeleri* Cockerell ...... 143

*Pinus* sp. Brooks.
Brooks, 1935, pl. 4, figs. 2, 3 only
= *Pinus harneyana* Chaney and
Axelrod ....................... 141

*Pinus* sp. Brooks.
Brooks, 1935, pl. 4, figs. 1, 4, 5 only
= rejected ............................ 206

*Pinus* sp. Dorf.
Dorf, 1936, p. 106
= *Pinus harneyana* Chaney and
Axelrod ....................... 141

*Pinus* sp. Knowlton.
Knowlton, 1927, pl. 8, fig. 9
= *Pinus harneyana* Chaney and
Axelrod ....................... 141

*Pinus* sp. Knowlton.
Berry, 1929, p. 239
= *Pinus harneyana* Chaney and
Axelrod ....................... 141

*Pinus* sp. Smith.
Smith, 1938a, pl. 28, fig. 8
= *Pinus harneyana* Chaney and
Axelrod ....................... 141

*Pinus* sp. Smith.
Smith, 1941, pl. 2, fig. 12
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*Pinus* spp. needles Brown.
Brown, 1937a, pl. 45, fig. 13
= *Pinus tiptoniana* Chaney and
Axelrod ....................... 142

Pinus spp. seeds of pine Brown
Brown, 1937a, pl. 45, figs. 14, 17, 20
= Pinus tiptoniana Chaney and
Axelrod ........................ 142
Pinus spp. seeds of pine Brown.
Brown, 1937a, pl. 45, figs. 15, 16
= Picea sonomensis Axelrod ..... 141
Pinus spp. seeds of pine Brown.
Brown, 1937a, pl. 45, fig. 26
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Lesquereux, 1888, p. 19
= Alnus relatus (Knowlton) Brown 159
Planera ungeri Ettingshausen.
Knowlton, 1902, p. 55
= Alnus relatus (Knowlton) Brown 159
Platanus aceroides (Goeppert) Heer.
Lesquereux, 1888, pl. 5, fig. 7
= Platanus dissecta Lesquereux. 182
Platanus aceroides Goeppert.
Arnold, 1937, pl. 3, fig. 1
= Platanus dissecta Lesquereux. 182
Platanus aceroides ? (Goeppert) Heer.
Knowlton, 1902, p. 65
= Platanus dissecta Lesquereux. 182
Platanus aspera ? Newberry.
Knowlton, 1898, p. 732
= rejected ............................ 206
Platanus aspera Newberry.
Berry, 1931, p. 34
= Platanus dissecta Lesquereux. 182
Platanus nobilis Newberry.
Lesquereux, 1888, p. 19
= Platanus dissecta Lesquereux. 182
Platanus nobilis ? Newberry.
Knowlton, 1902, p. 65
= Platanus dissecta Lesquereux. 182
Platanus raynoldsii Newberry.
Lesquereux, 1888, p. 19
= Platanus dissecta Lesquereux. 182
Platanus sp. Knowlton.
Knowlton, 1902, p. 66
= Platanus dissecta Lesquereux. 182
Populus alexanderi Dorf.
Smith, 1939b, p. 110
= incertae sedis ..................... 203
Populus booneana Smith.
Smith, 1941, pl. 2, figs. 14, 15
= Populus washoensis Brown .... 152
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Lesquereux, 1888, p. 18
= rejected ............................ 206
Populus lesquereuxi Cockerell.
Berry, 1931, p. 35
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Berry, 1934, p. 106
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Knowlton, 1902, pl. 2, fig. 1
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Populus lindgreni Knowlton.
MacGinitie, 1933, p. 49 (part)
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Populus lindgreni Knowlton.
MacGinitie, 1933, p. 49 (part)
= Populus voyana Chaney and
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Vaccinium salicoides Knowlton.
Knowlton, 1926, pl. 28, figs. 9, 9a
= incertae sedis ..................... 202
Viburnum fernquisti Berry.
Berry, 1931, p. 34
= incertae sedis ........................ 203
Vincetoxicum ? trinervata MacGinitie.
MacGinitie, 1933, pl. 15, fig. 1
= incertae sedis .................... 203

## Additional Changes

During our taxonomic studies we have noted some additional errors in identification. They include the following, which are not treated under the species described in the preceding pages.

Alnus sp. Dorf.
Dorf, 1936, p. 112
= Alnus rubroides Axelrod
Cassia idahoensis Knowlton.
Berry, 1934, p. 144
= Sophora spokanensis Knowlton
Cassia obtusa Knowlton.
Knowlton, 1898, pl. 100, fig. 5 only
= Salix spokanensis (Berry) Brown
Cassia sophoroides (Knowlton) Berry.
Berry, 1934, p. 144
= Sophora spokanensis Knowlton
Cassia spokanensis Knowlton.
Berry, 1931, p. 34
= Sophora spokanensis Knowlton
Dryopteris idahoensis Knowlton.
Berry, 1934, pl. 19, figs. 2, 3
= Pteris idahoensis (Knowlton) Brown
Dryopteris idahoensis Knowlton.
Dorf, 1936, p. 105
= Pteris idahoensis (Knowlton) Brown
Fagopsis longifolia (Lesquereux) Hollick.
Berry, 1934, p. 108
= Ulmus moorei Chaney and Elias
Ficus ? washingtonensis Knowlton.
Berry, 1934, p. 111
= Exbucklandia oregonensis (Chaney)
Brown

This specimen is from Whitebird, Idaho, not from the Cove Creek locality of the Lower Idaho flora.

Laurus grandis Lesquereux.
Berry, 1934, p. 120
= Magnolia dayana Cockerell
Laurus similis Knowlton.
Berry, 1931, p. 34
= Persea lanceolata (Berry) Brown
Laurus similis Knowlton.
Berry, 1934, p. 121
= Persea lanceolata (Berry) Brown
Mahonia trainii Arnold.
Arnold, 1936a, pl. 3, figs. 4, 6, 8
= Mahonia malheurensis Arnold

The living species Mahonia fortunei Schneider and M. confusa Sprague have leaflets of both the trainii and malheurensis types on the same leaf; the two fossil species are therefore synonymized.

Mahonia trainii Arnold.
Smith, 1939b, pl. 3, fig. 2
= Mahonia malheurensis Arnold

Myrica lanceolata Knowlton.
Knowlton, 1898, pl. 99, fig. 6 only
= Salix payettensis Axelrod

Myrica undulata ? Heer.
Lesquereux, 1878b, pl. 17, fig. 8
= Comptonia hesperia Berry

Nyssa magnifica (Knowlton) Berry.
Berry, 1931, p. 34
= Cocculus heteromorpha (Knowlton) Berry

Populus lindgreni Knowlton.
Berry, 1931, p. 34
= Vitis bonseri Berry

Populus lindgreni Knowlton.
Berry, 1934, p. 106
= Vitis bonseri Berry

Populus washingtonensis Knowlton.
Berry, 1931, p. 34
= Vitis bonseri Berry

Prunus coveus Chaney.
Chaney, 1927, pl. 15, fig. 3 only
= Rosa hilliae Lesquereux

Quercus cognatus Knowlton.
Berry, 1931, p. 34
= Quercus payettensis Knowlton

Quercus cognatus Knowlton.
Berry, 1934, p. 109
= Quercus payettensis Knowlton

Quercus treleasii Berry.
Berry, 1931, p. 37
= Sophora spokanensis Knowlton

Quercus treleasii Berry.
Berry, 1934, p. 110
= Sophora spokanensis Knowlton

Rhus merrilli Chaney.
Berry, 1934, p. 116
= Cedrela pteraformis (Berry) Brown

Rhus merrilli Chaney.
Berry, 1938, p. 89
= Cedrela pteraformis (Berry) Brown

Salix angusta Al. Braun.
Knowlton, 1898, pl. 99, fig. 12
= Salix spokanensis (Berry) Brown

Salix inquirenda Knowlton.
Arnold, 1937, pl. 1, fig. 4
= Populus payettensis (Knowlton) Axelrod

Salix sp. Knowlton.
MacGinitie, 1933, p. 49
= Salix payettensis Axelrod

Sophora alexanderi Knowlton.
Berry, 1934, p. 116
= Sophora spokanensis Knowlton

Ulmus speciosa Newberry.
Dorf, 1936, p. 116
= Ulmus californica Lesquereux

Umbellularia lanceolata Berry.
Berry, 1941, p. 34
= Persea lanceolata (Berry) Brown

Vitis washingtonensis (Knowlton) Brown.
Brown, 1937a, p. 181, pl. 56, figs. 5, 6; pl. 57, figs. 1, 2, and all items in synonymy
= Vitis bonseri Berry

Leaves of V. washingtonensis occur in the Grand Coulee flora, the type locality of the seed V. bonseri Berry. Since both organs probably represent one species, the new combination proposed by Brown is here reduced to synonymy.

# PLATES

## PLATE 1

Fig. 1. Picture Gorge Saddle locality P3737, looking northwest from the Mascall Ranch in the valley of the East Fork of the John Day River. Columbia River basalt dipping under Mascall formation capped by Rattlesnake formation.

Fig. 2. Riverbank (Van Horn's Ranch) locality P28, on the East Fork of the John Day River 13 miles east of Dayville.

Fig. 3. White Hills locality P3735, looking southeast across the valley of the East Fork to the Aldrich Mountains.

Fig. 4. White Hills locality P3735, 13½ miles east of Dayville on the north side of the valley.

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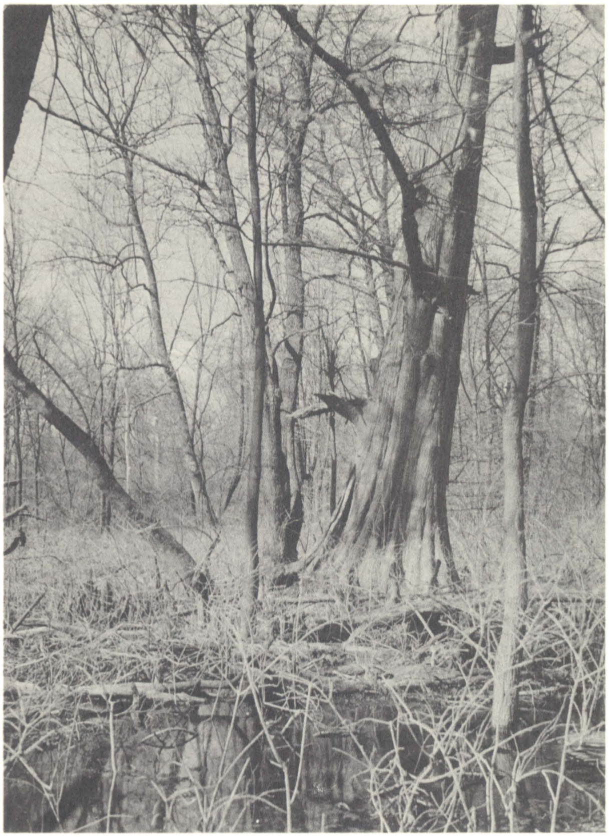
## PLATE 2

Fig. 1. Swamp cypress forest on flood plain of Wabash River opposite Mount Carmel, Illinois.

Fig. 2. Forest on the borders of Big Lake, Arkansas.

Fig. 3. *Taxodium distichum* and associated angiosperms on north border of Lake Pontchartrain, near Strader, Louisiana.



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## PLATE 3

Figs. 1, 2. Taxodium distichum and associated angiosperms near Strader, Louisiana.

Fig. 3. River swamp near Sanford, Florida. Swamp cypress with live oak and palmetto.

Fig. 4. Swamp cypress forest at Highland Hammock State Park, Florida. Angiosperms include live oak, hickory, water gum, red maple.

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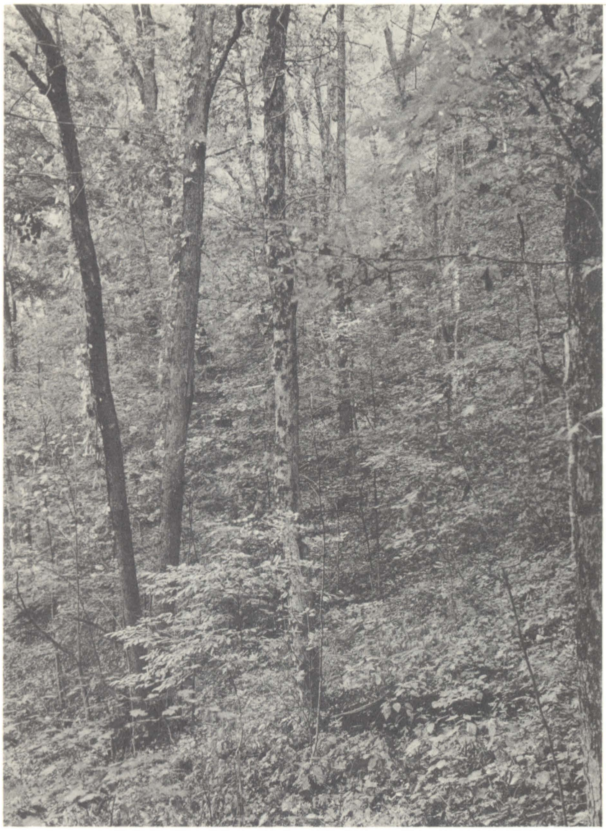
## PLATE 4

Mixed Mesophytic Forest on slopes of Cumberland Mountains, at altitude of approximately 3000 feet. Species occurring here are listed as equivalents on page 114.



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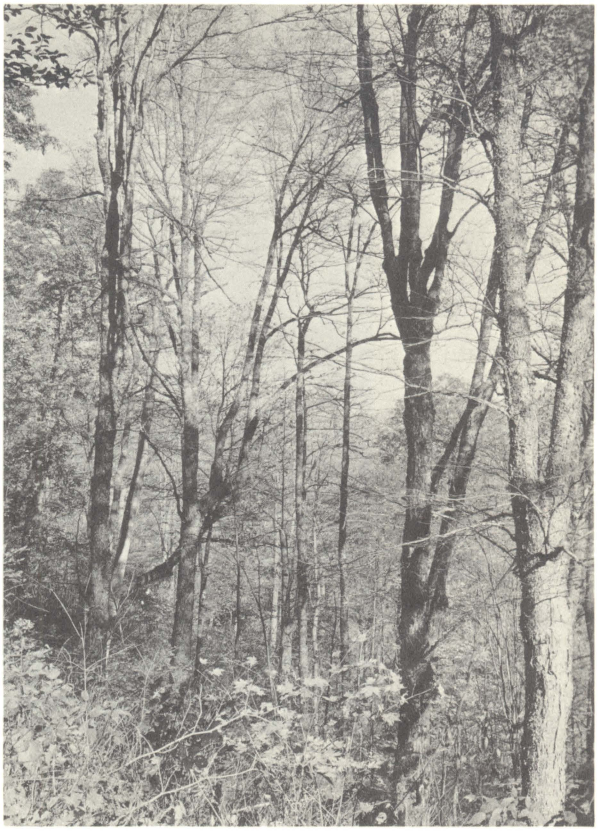

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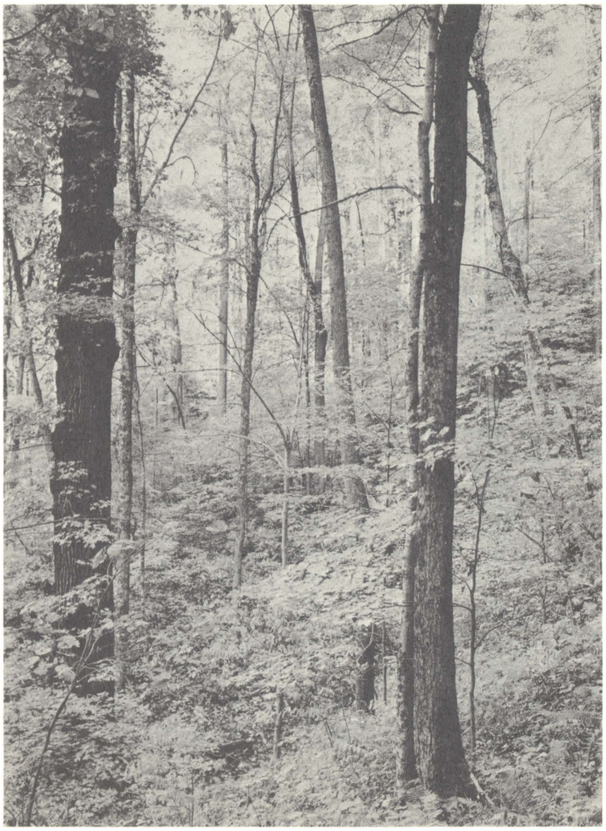

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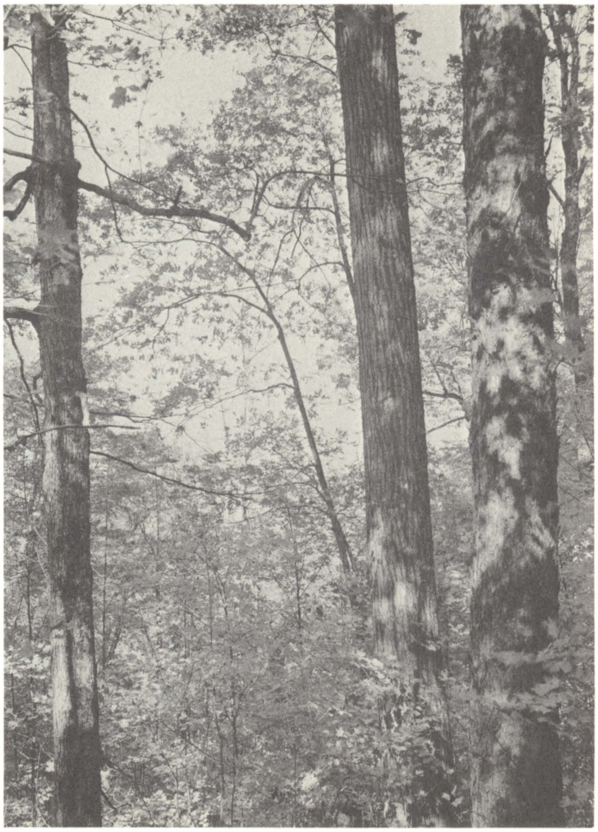

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## PLATE 5

Fig. 1. Winter aspect of natural stand of *Metasequoia glyptostroboides*, at Shui-hsa-pa, western Hupeh.

Fig. 2. Subalpine coniferous forest with birch and alder, on Mount Hiuchi, Honshu. (Photo by Dr. S. Watari.)

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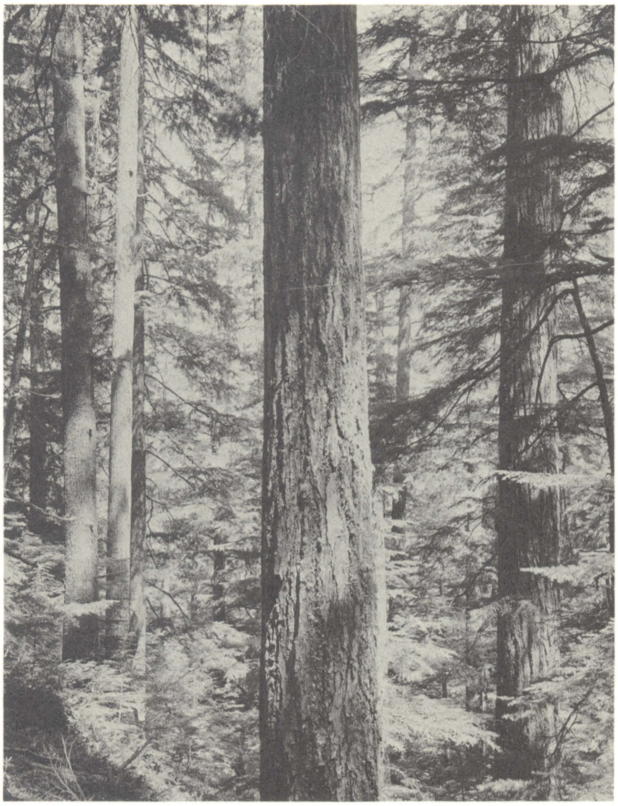
## PLATE 6

Fig. 1. Coniferous forest in the Cascades, elevation 1000 feet. Douglas fir and hemlock, with understory of maple and hazel.

Fig. 2. Subalpine forest in the San Juan Mountains, Colorado. Spruce and aspen.



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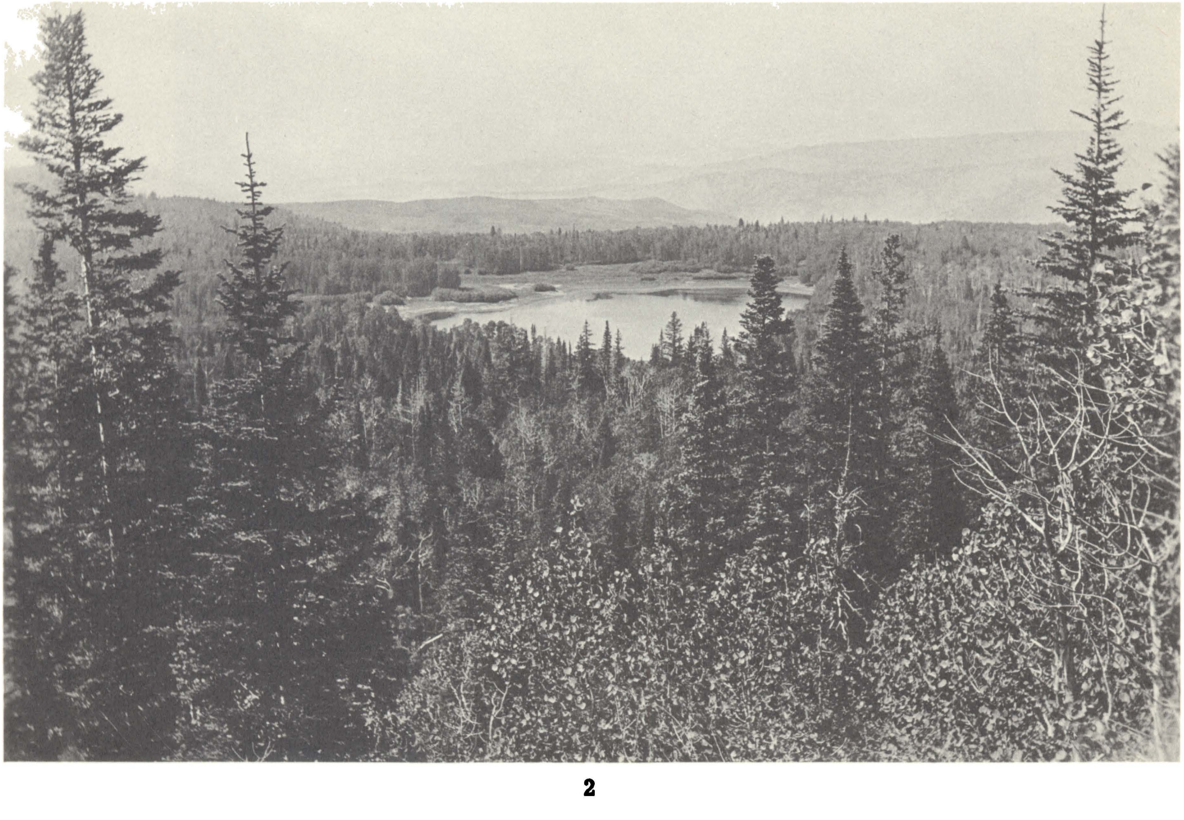

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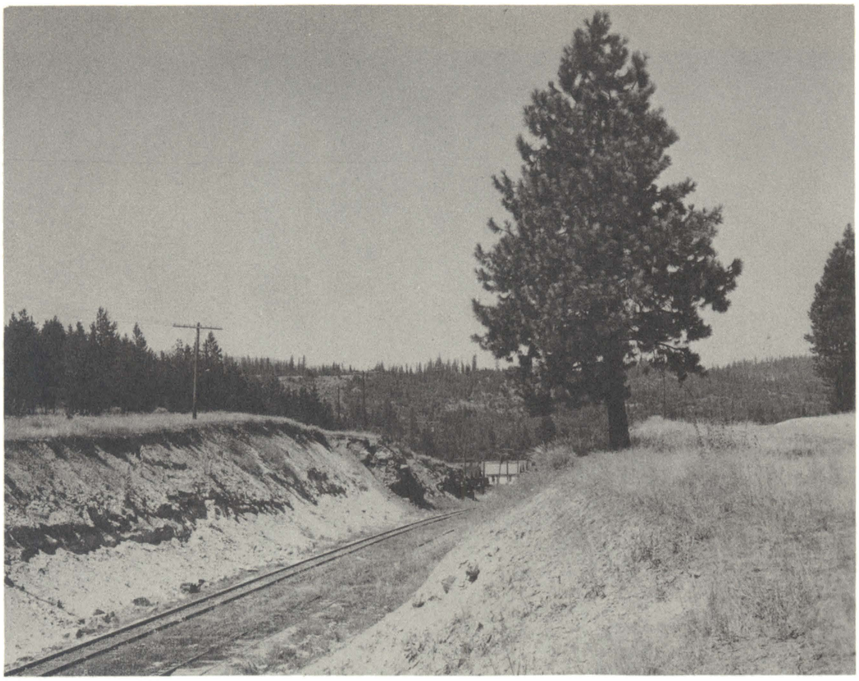
## PLATE 7

Fig. 1. Leaf-bearing ash at Austin, locality P3937.

Fig. 2. Leaf-bearing ash at Tipton, locality P3936.



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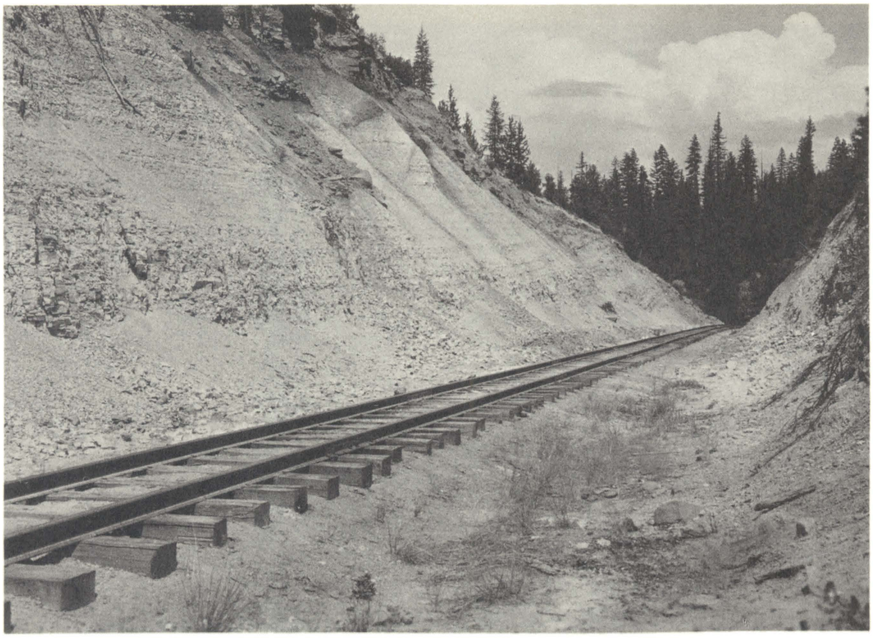

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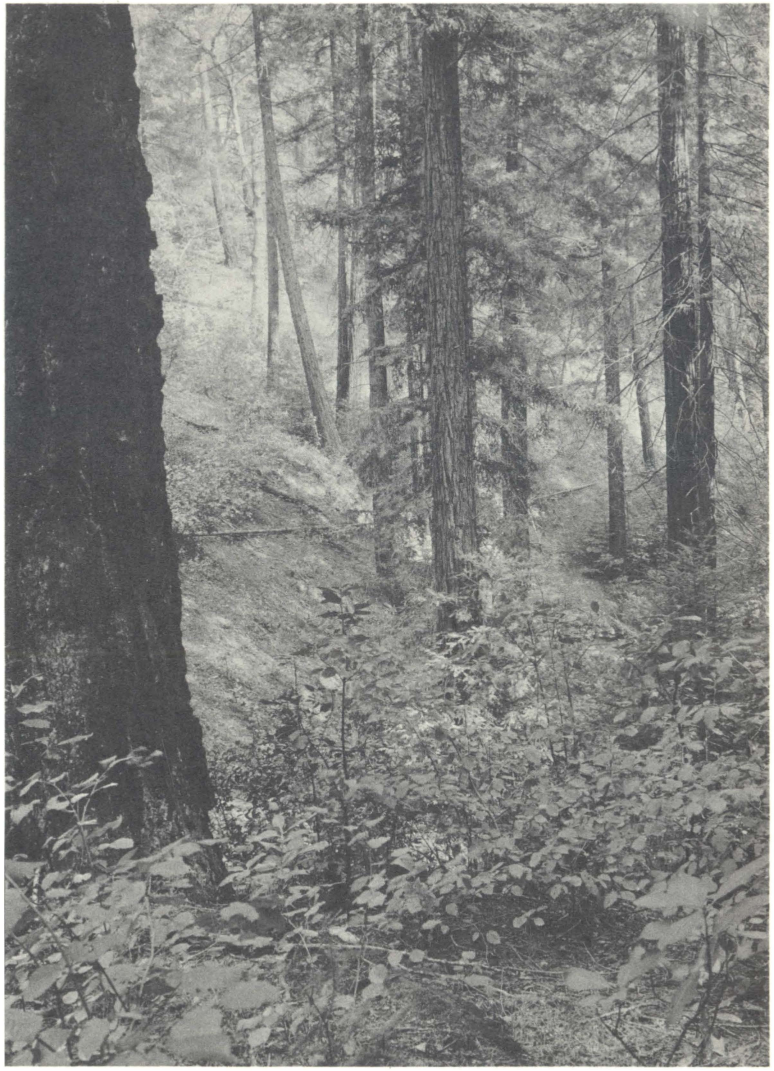
## PLATE 8

Fig. 1. Redwood with Douglas fir and valley oak on Howell Mountain, California, elevation 1550 feet.

Fig. 2. Glyptostrobus pensilis growing under cultivation in the botanical gardens at Kyoto University, Japan. (Photo by D. Schmidt.)



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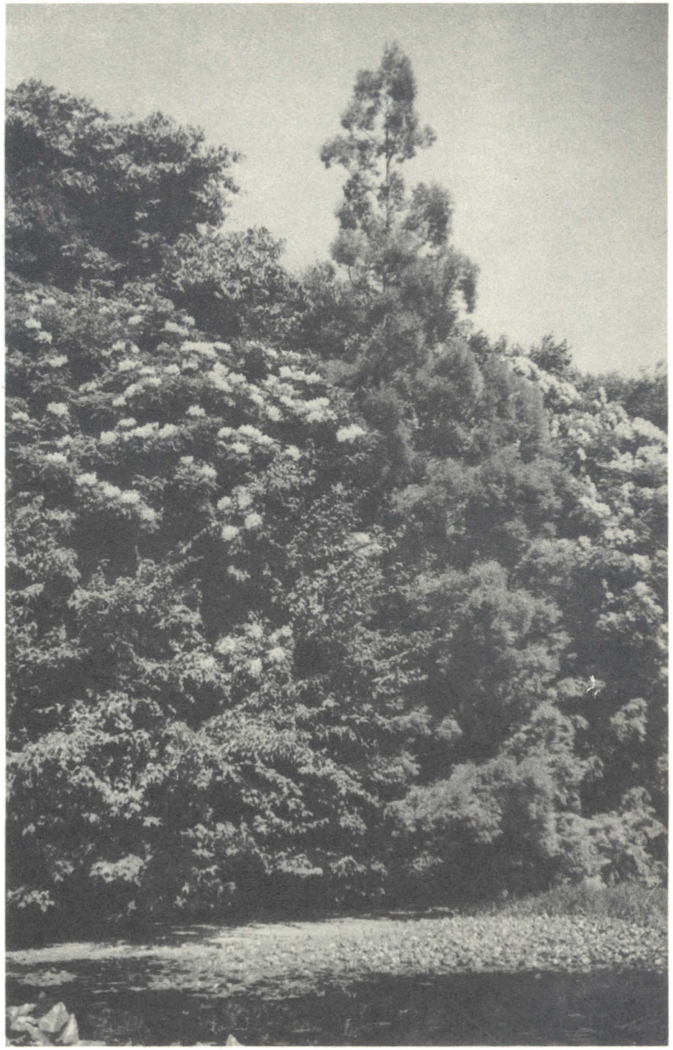

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## PLATE 9

Fig. 1. Inland occurrence of *Sequoia sempervirens* in the Coast Ranges, Napa County, California.

Fig. 2. The Stinking Water Basin. Locality P4120 near left center.

Fig. 3. Leaf-bearing ash at locality P4120.

Fig. 4. Tree trunks embedded in basalt, locality P4007.

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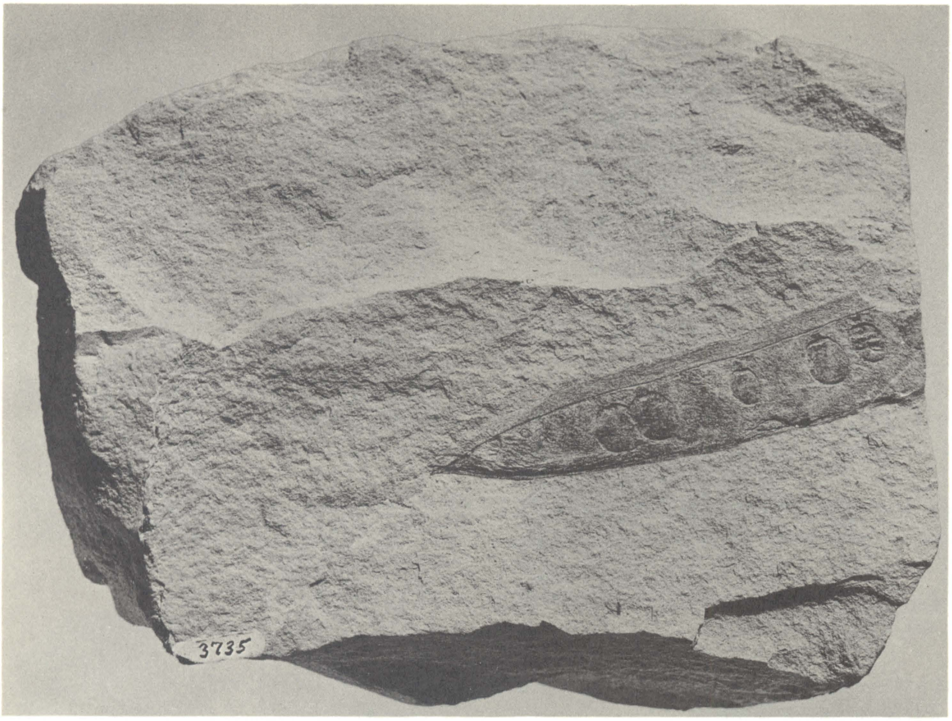

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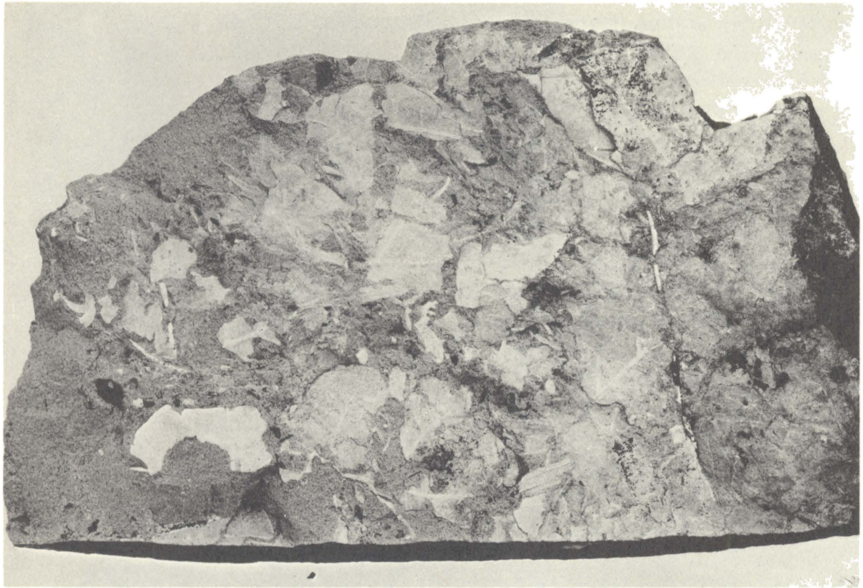

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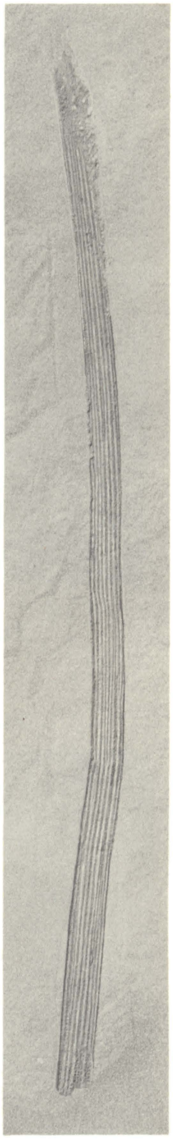

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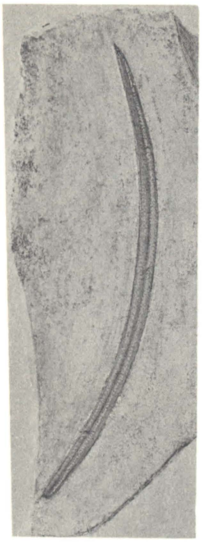
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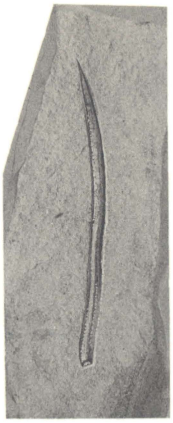
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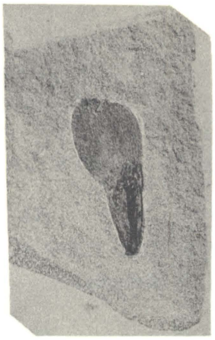
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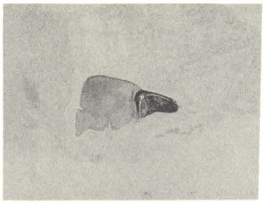
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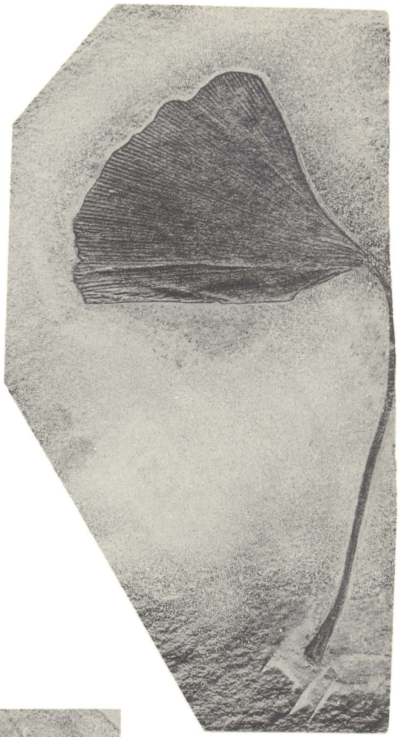
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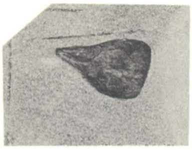
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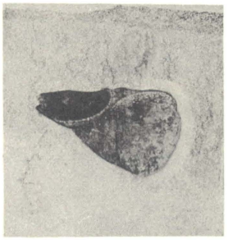
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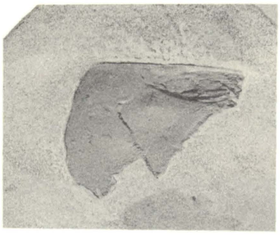
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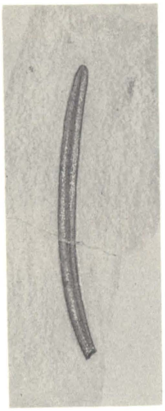
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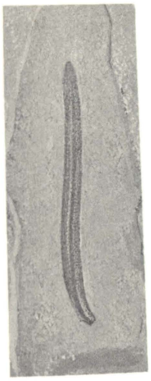
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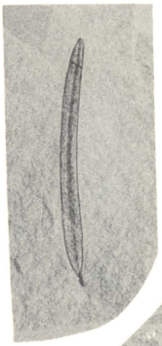
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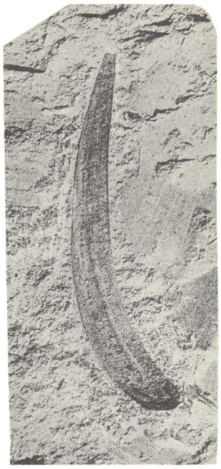
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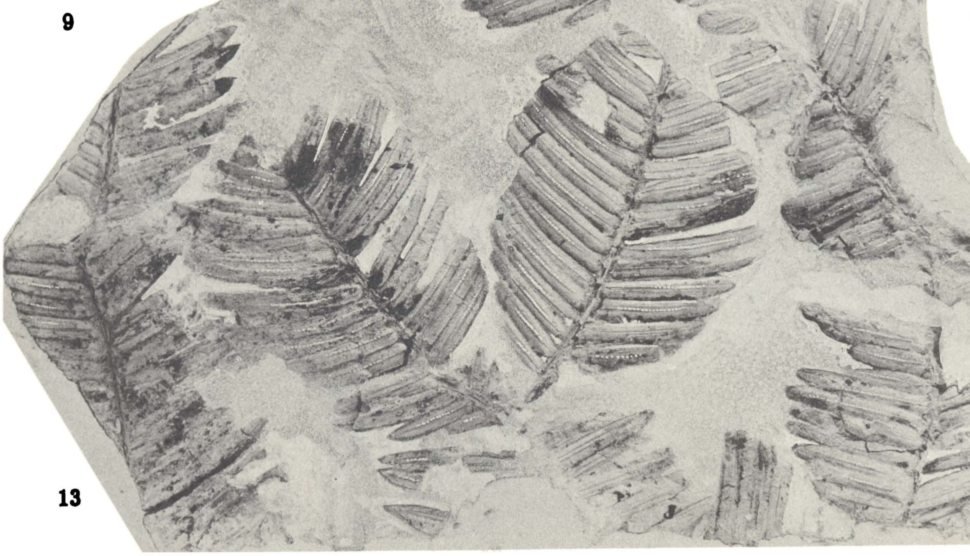
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## PLATE 12

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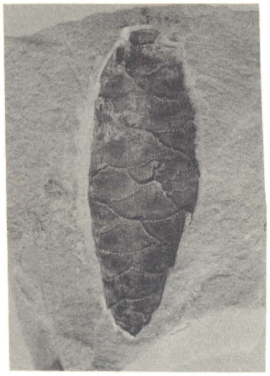

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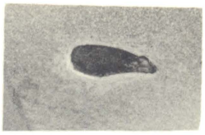

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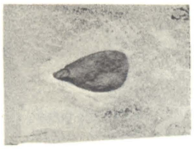

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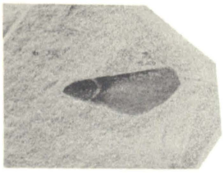

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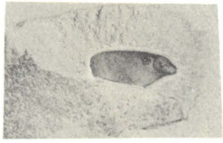

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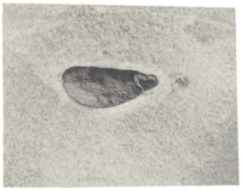

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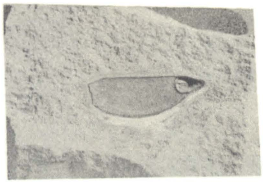

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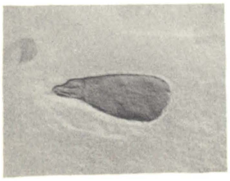

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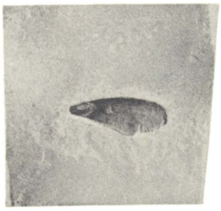

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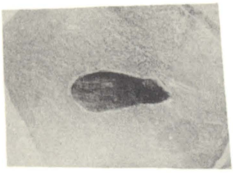

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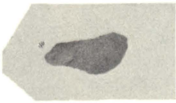

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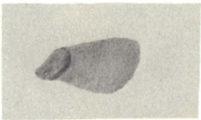

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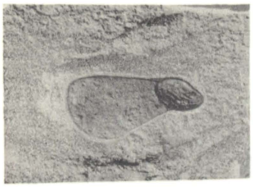

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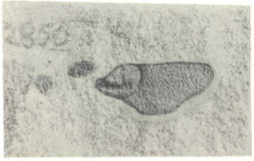

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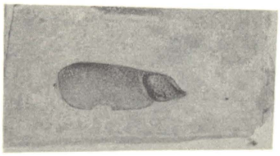

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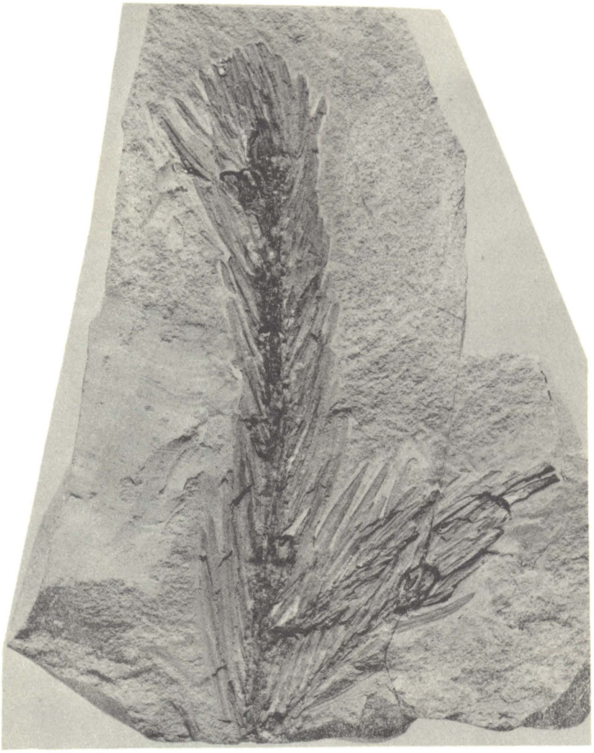

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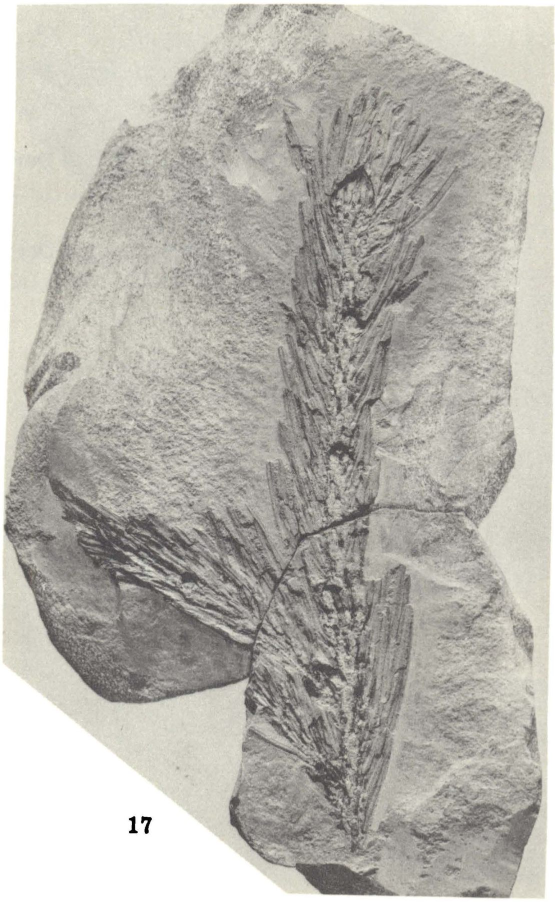

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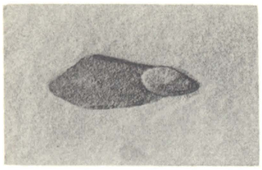

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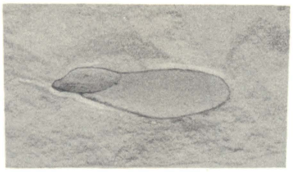

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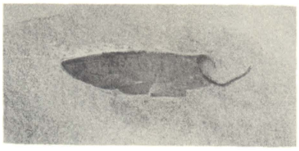

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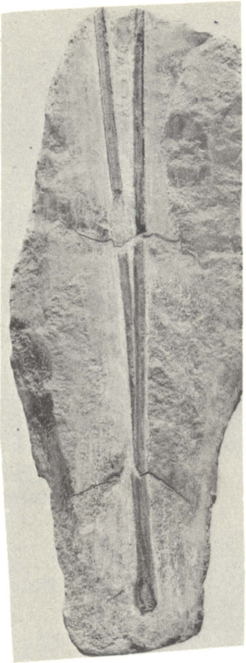

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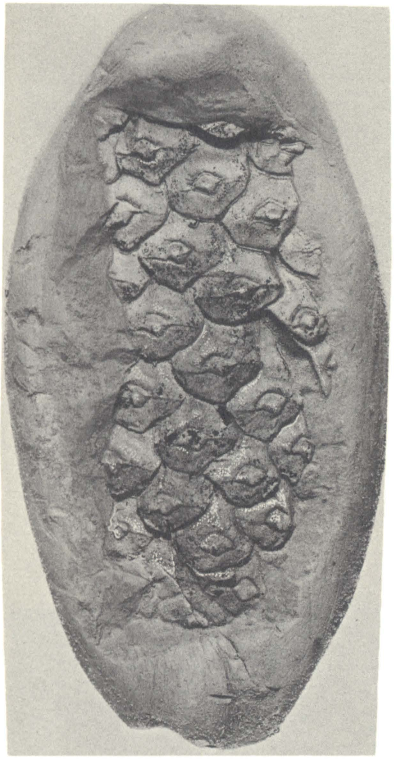

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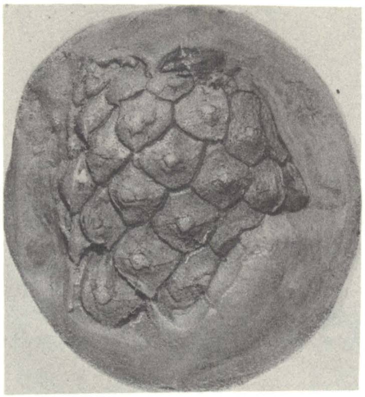

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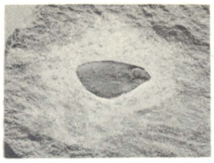

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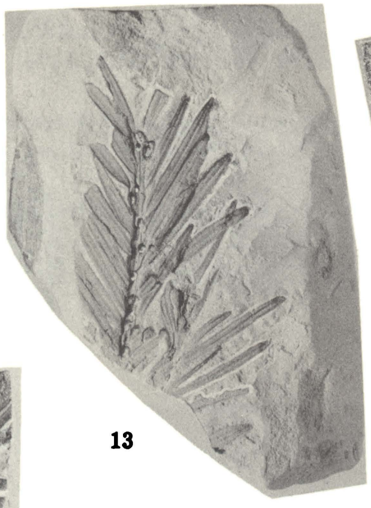

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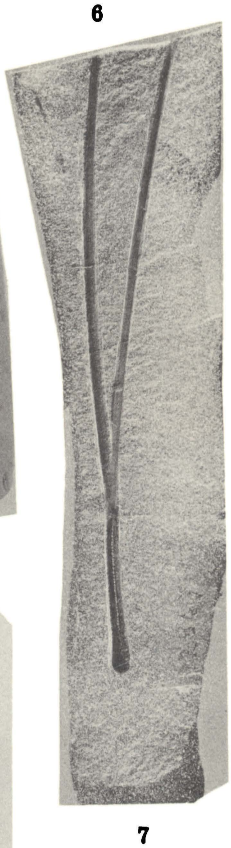

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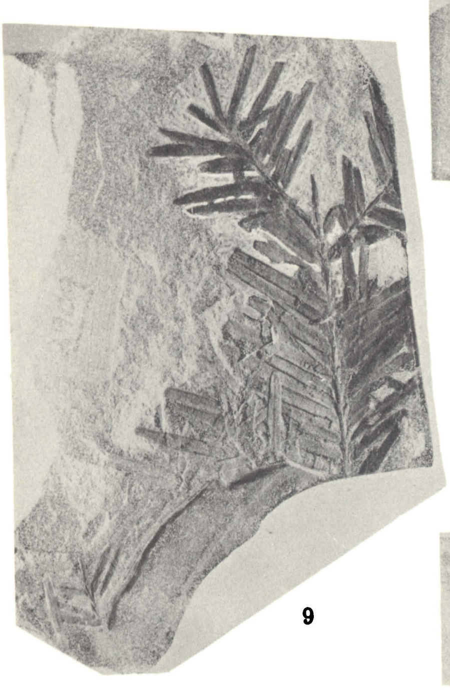

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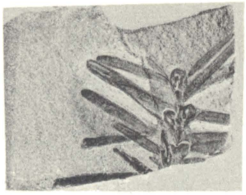

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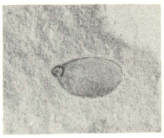

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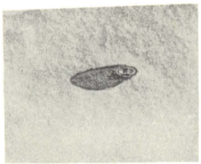

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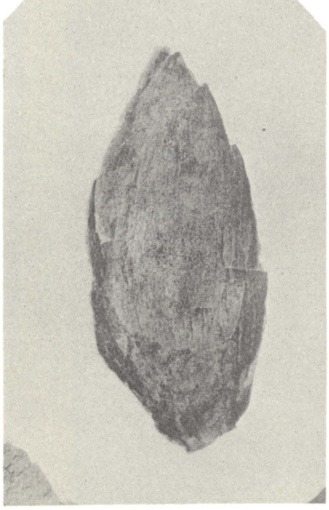

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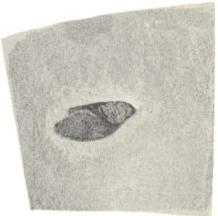

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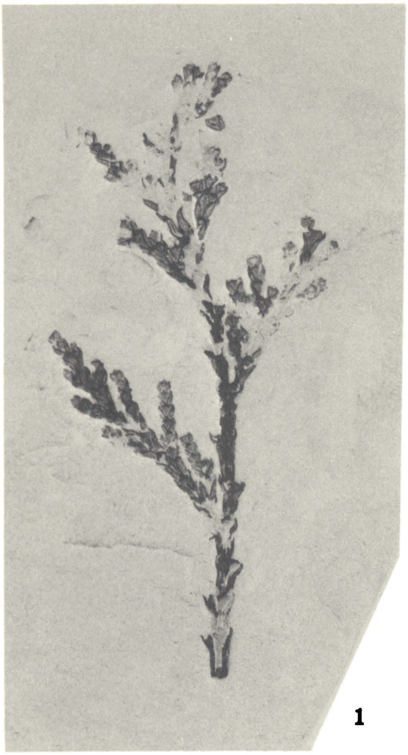
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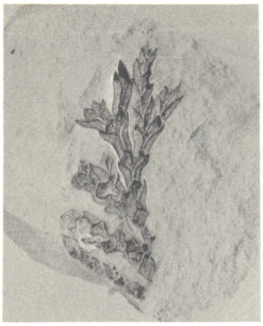
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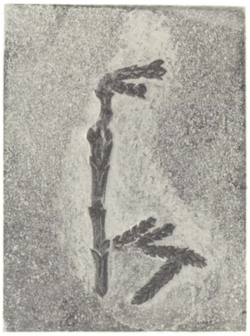
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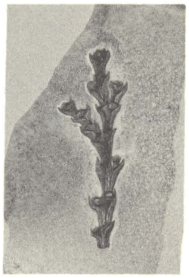
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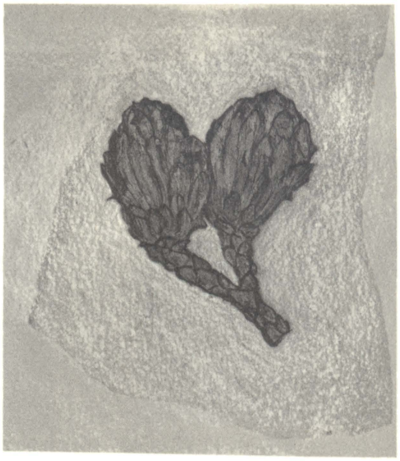
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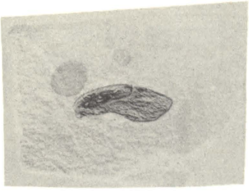
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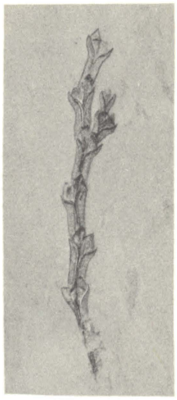
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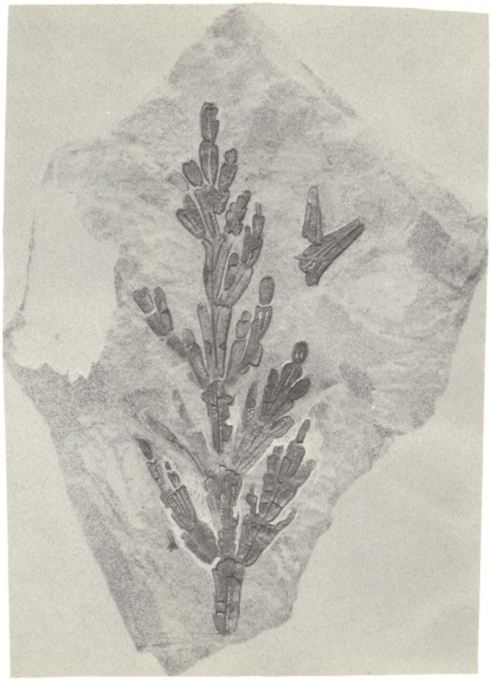
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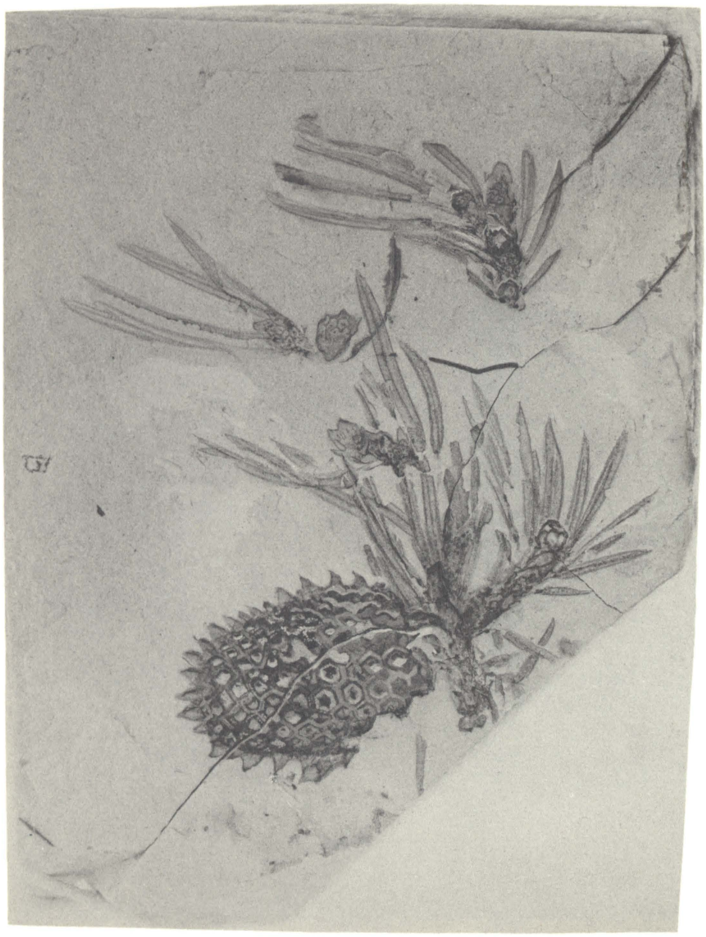
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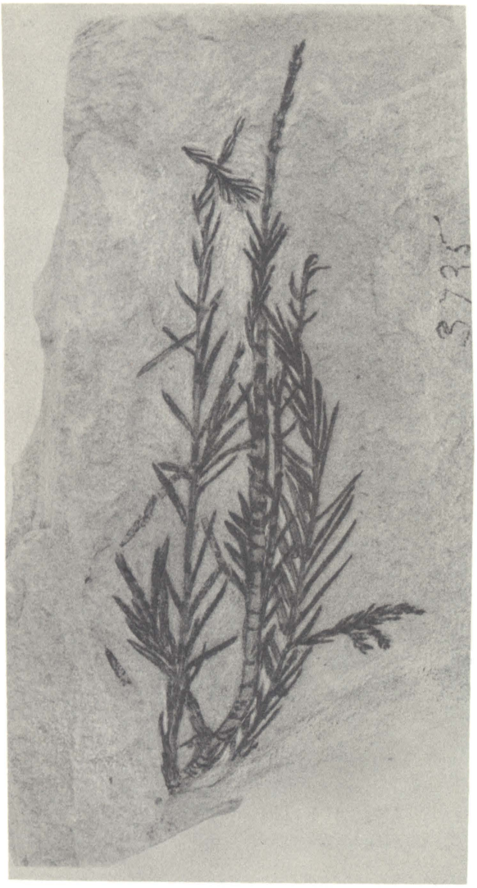

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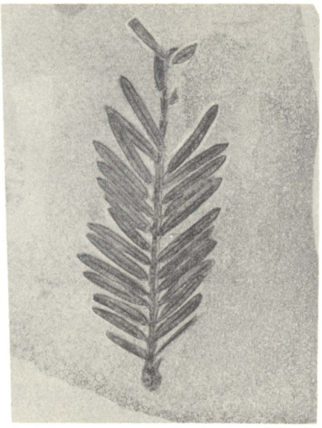

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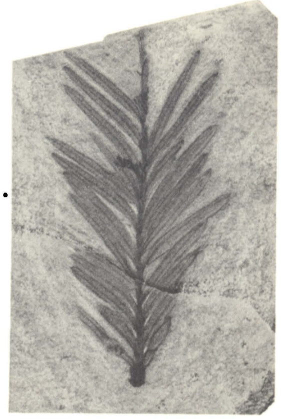

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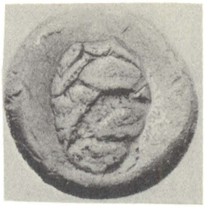

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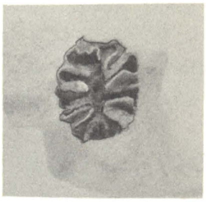

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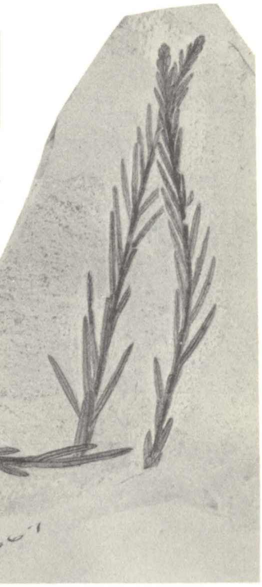

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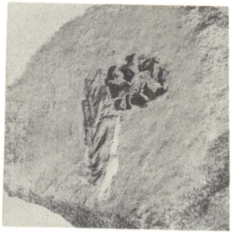

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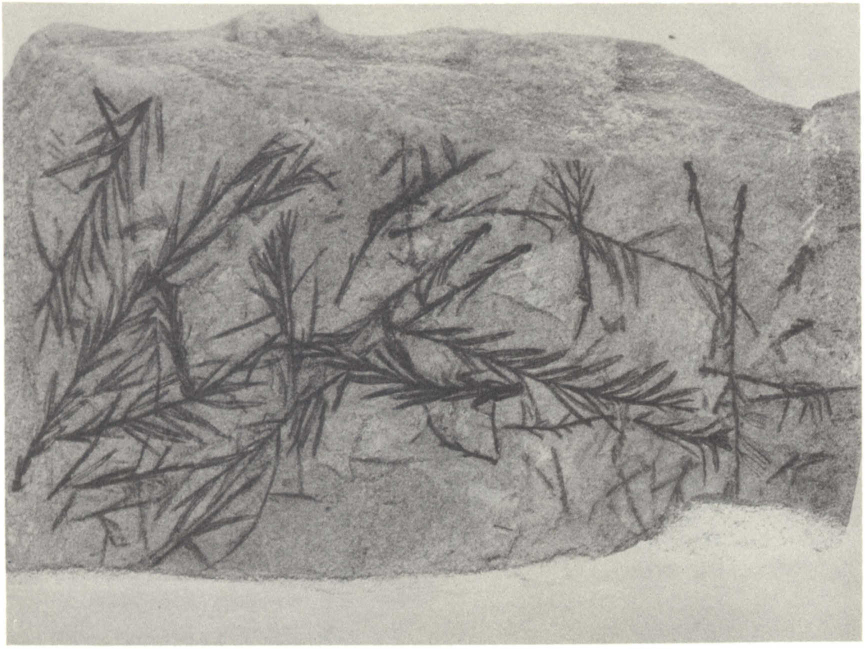

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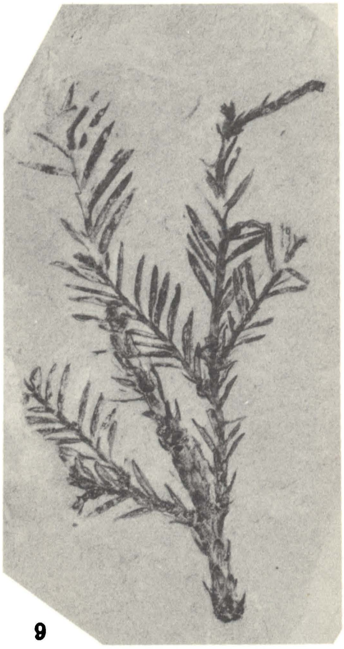

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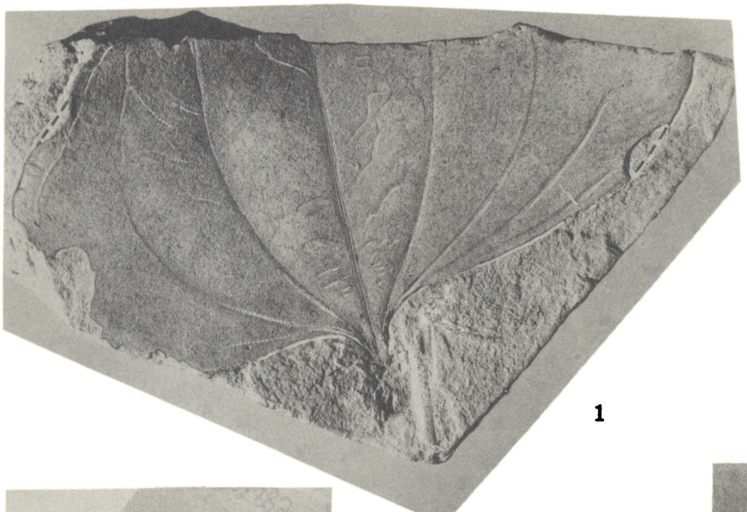

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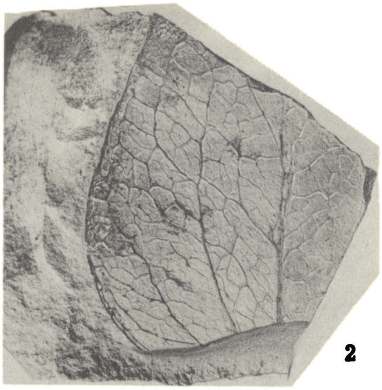

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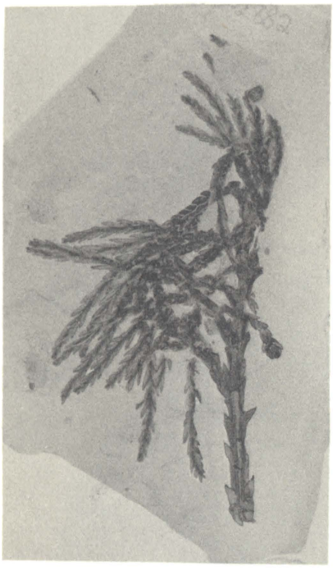

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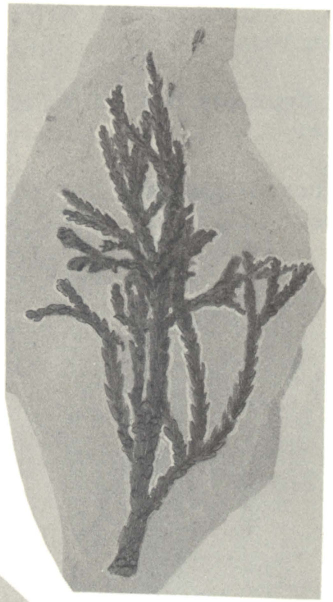

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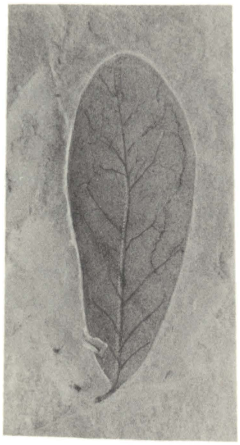

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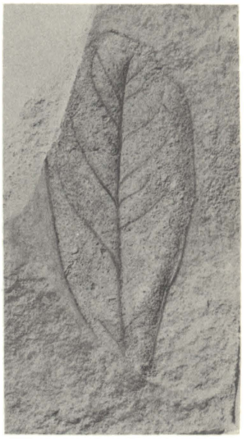

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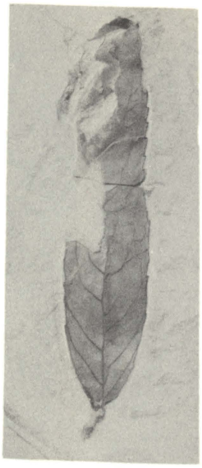

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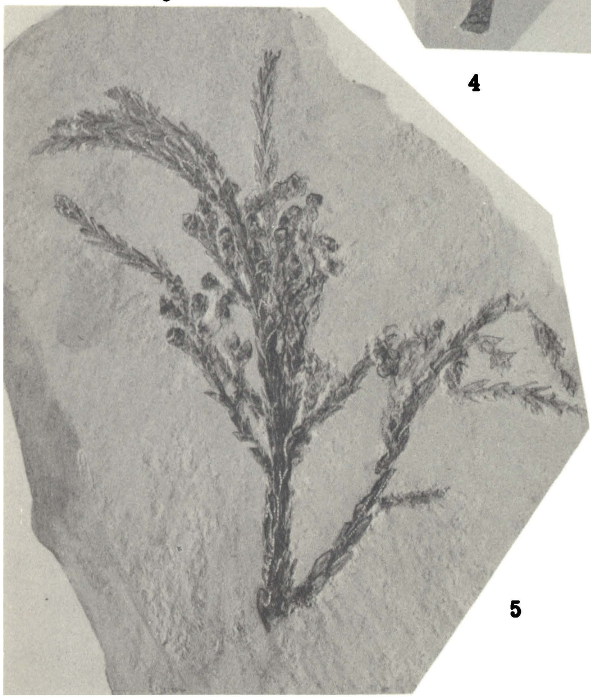

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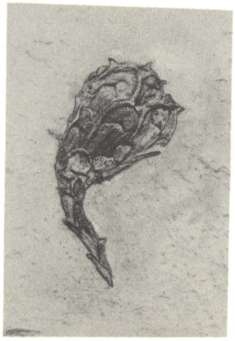

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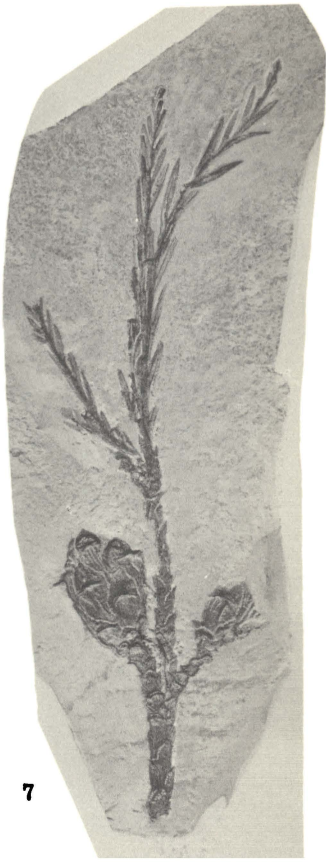

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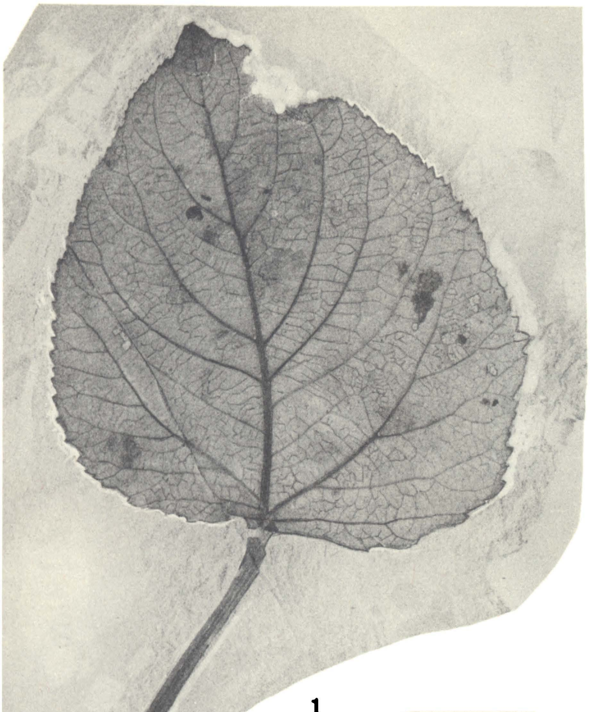

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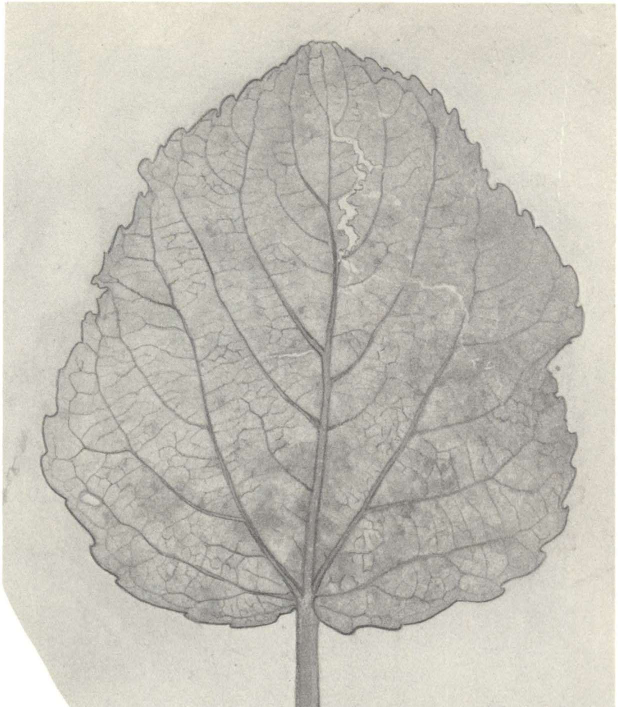

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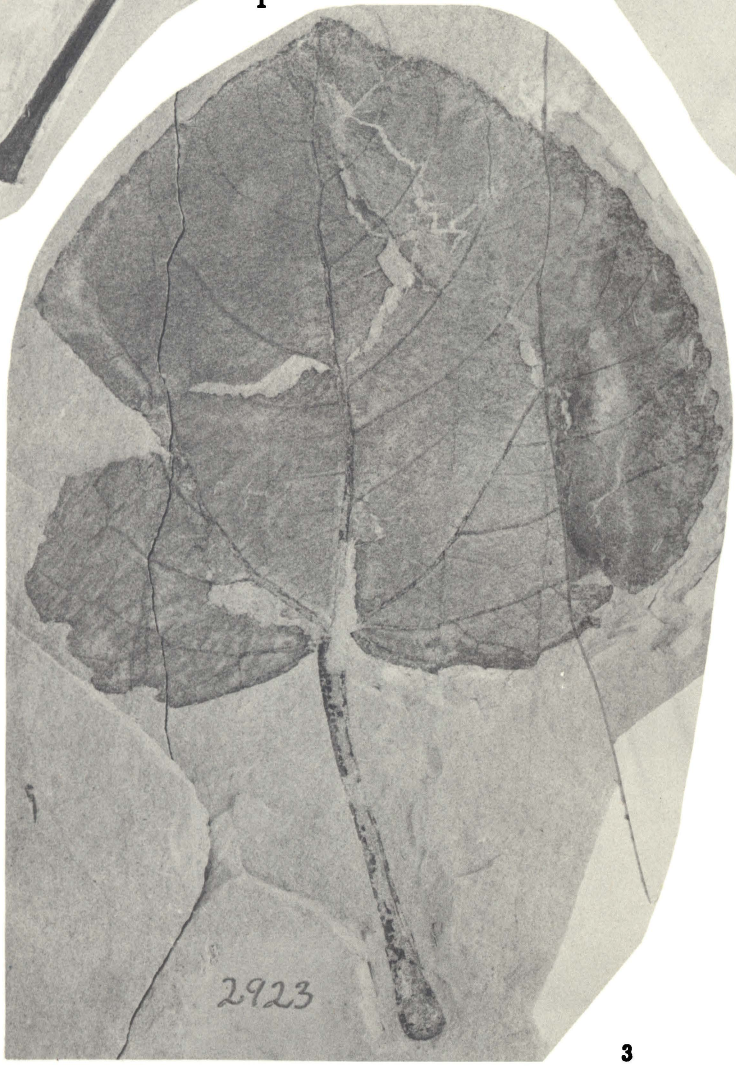

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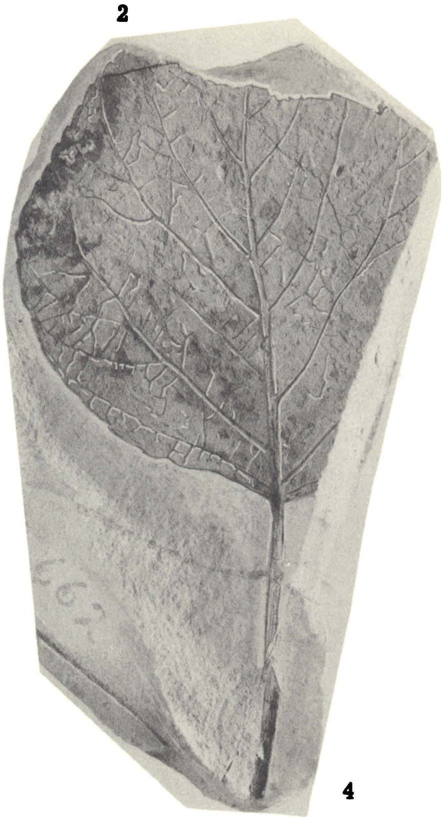

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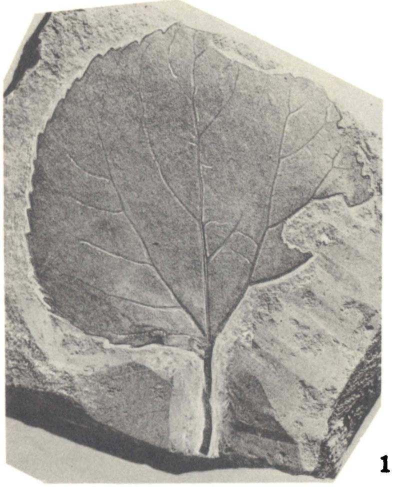

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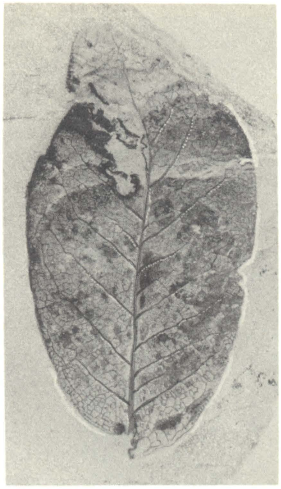

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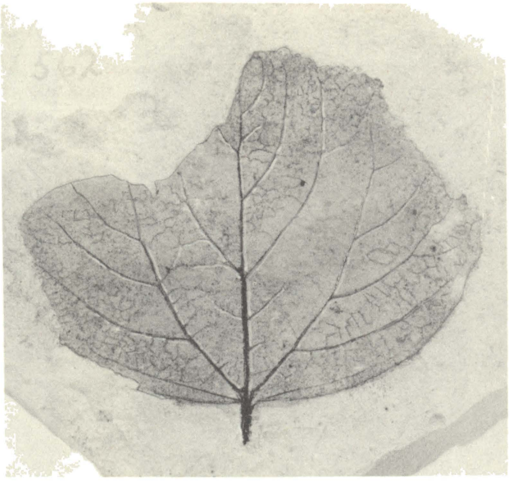

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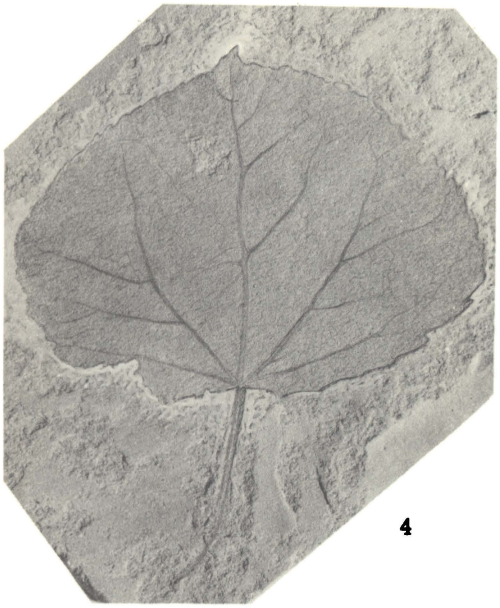

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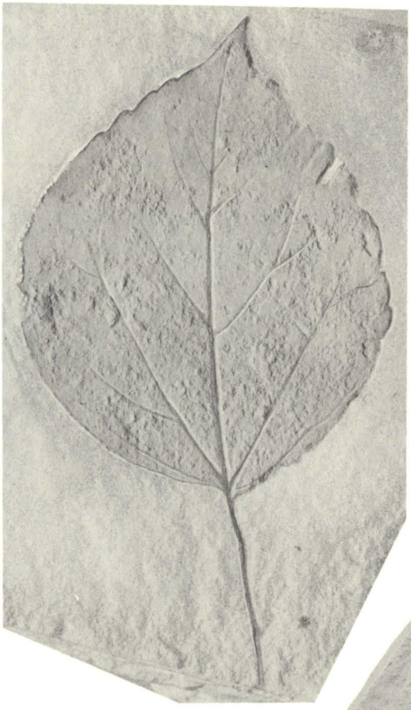

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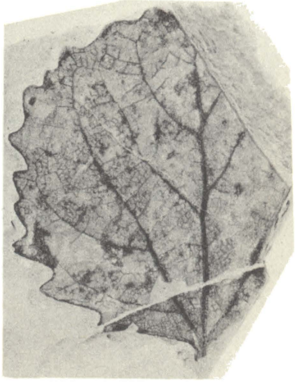

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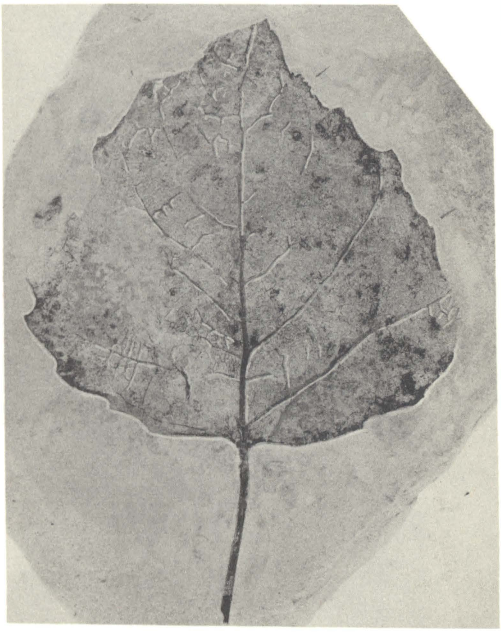

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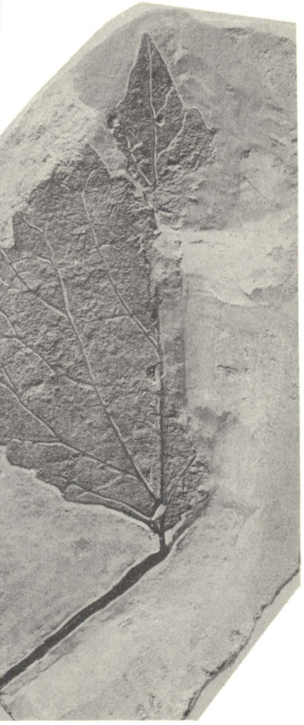

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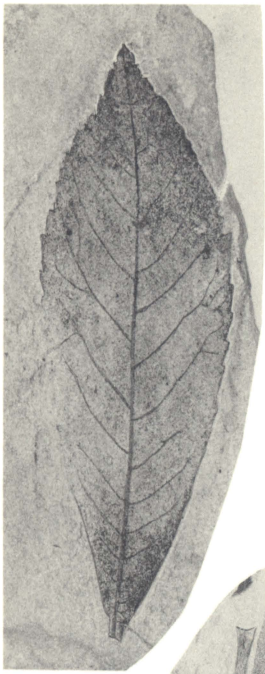

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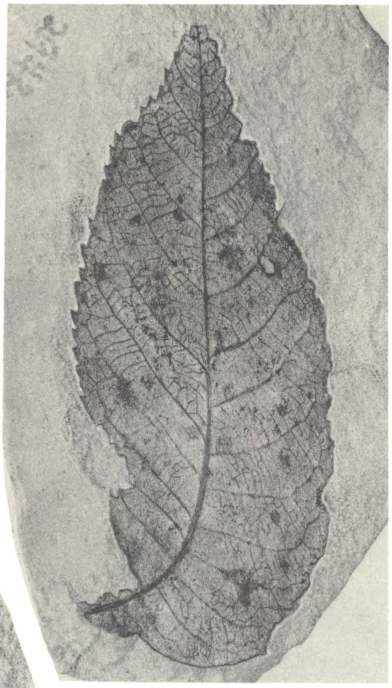

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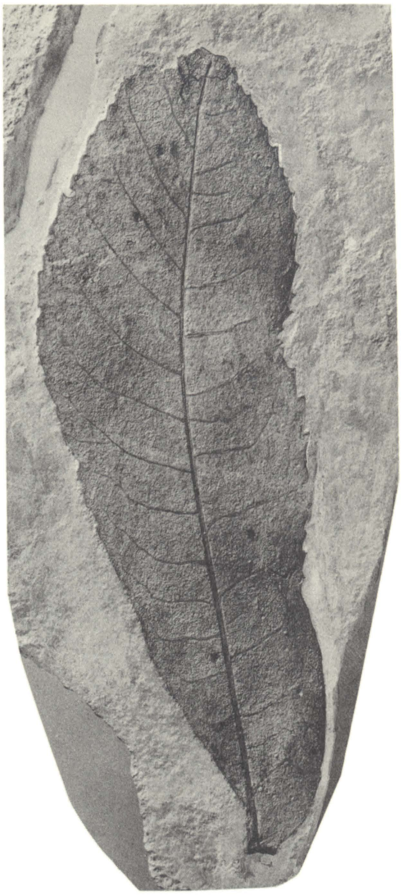

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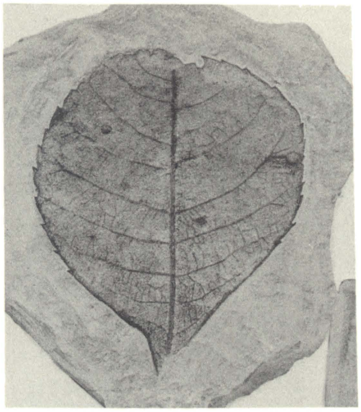

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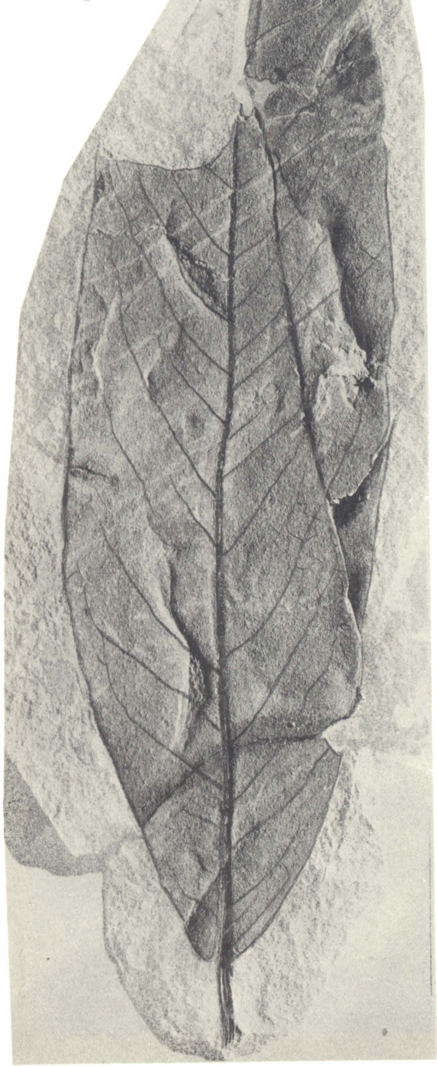

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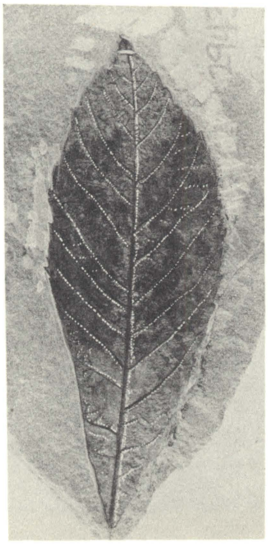

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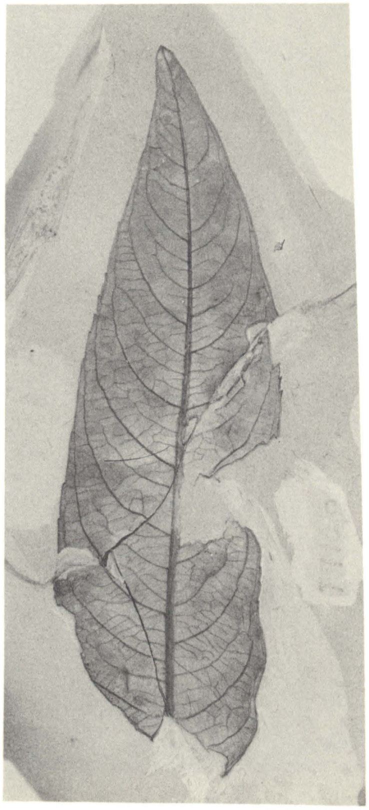

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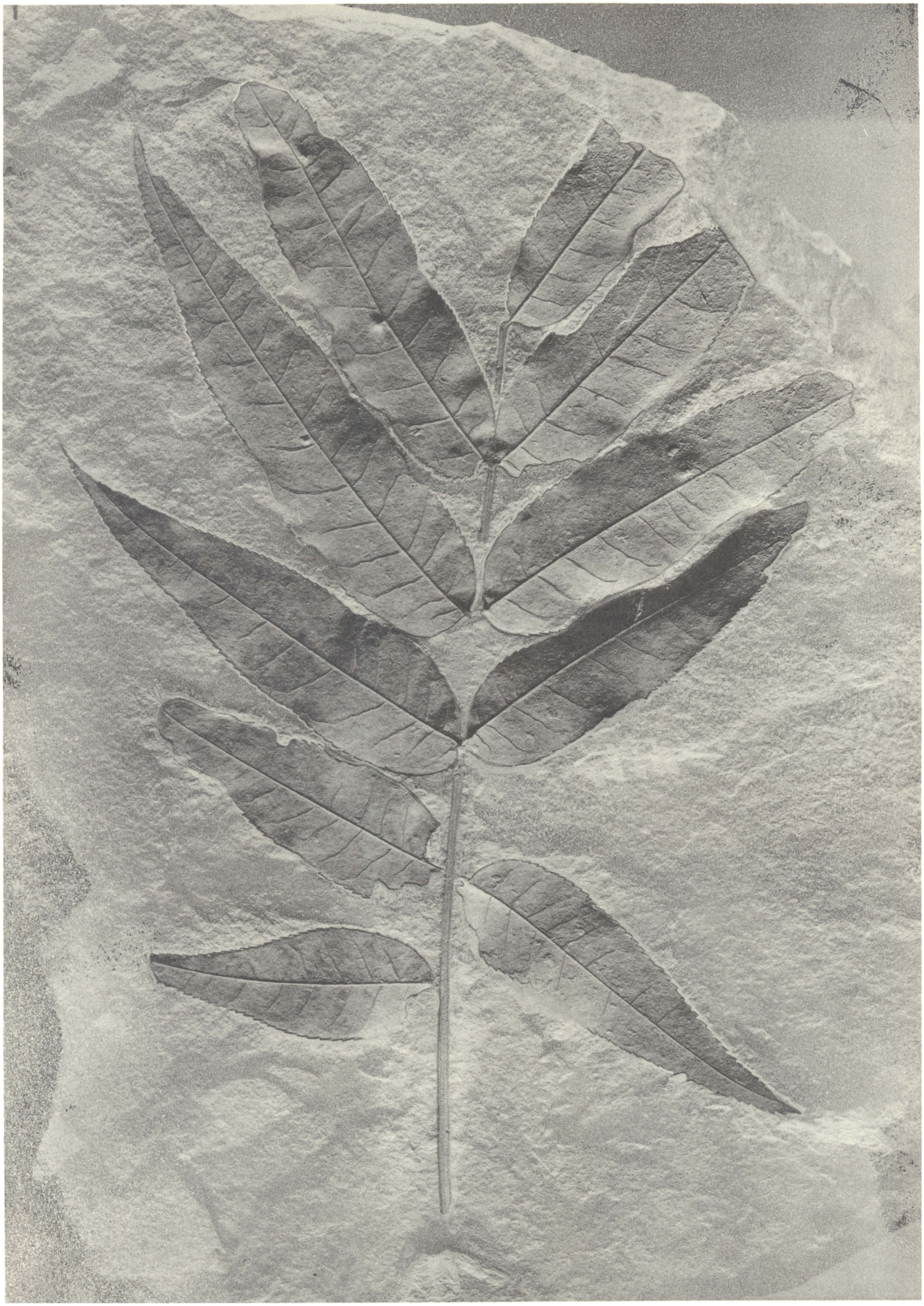

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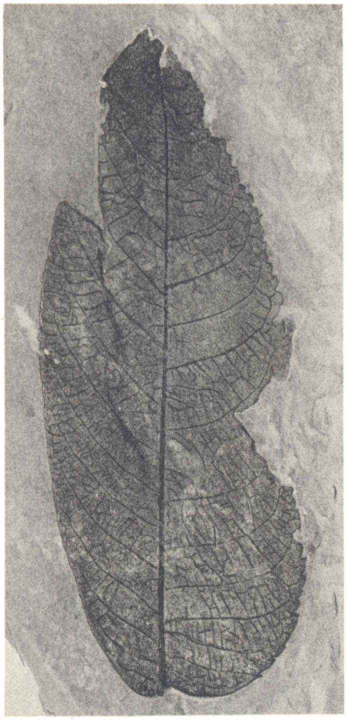
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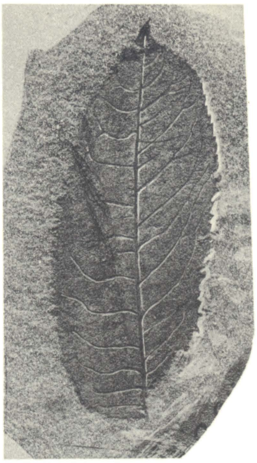
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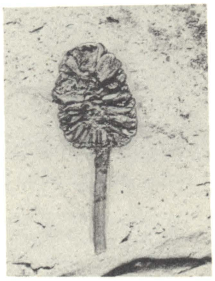
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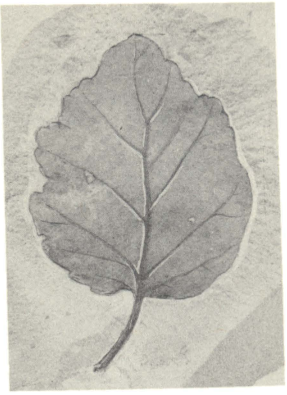
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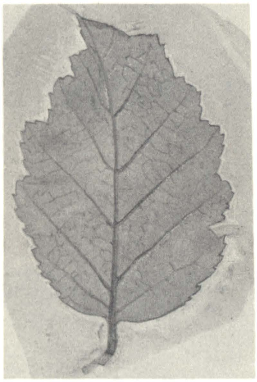
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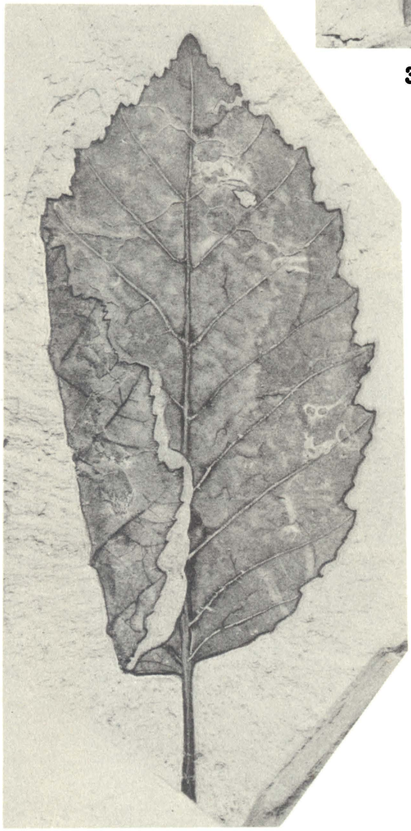
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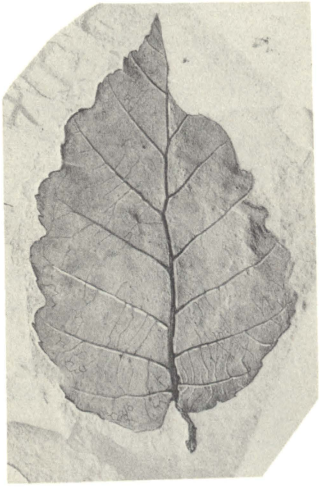
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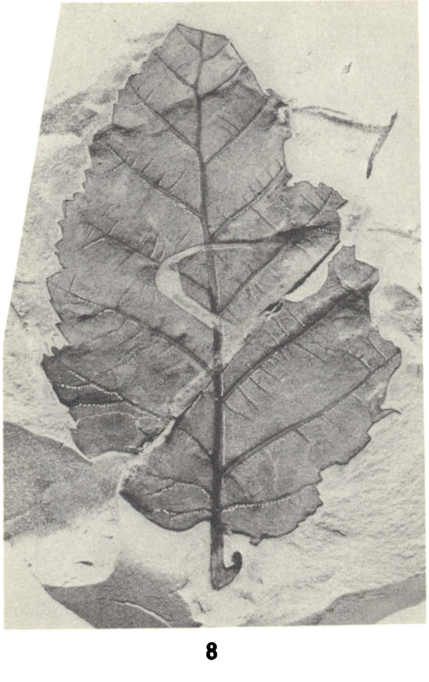
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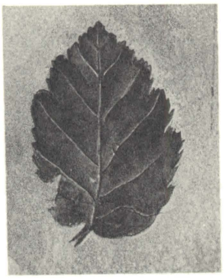
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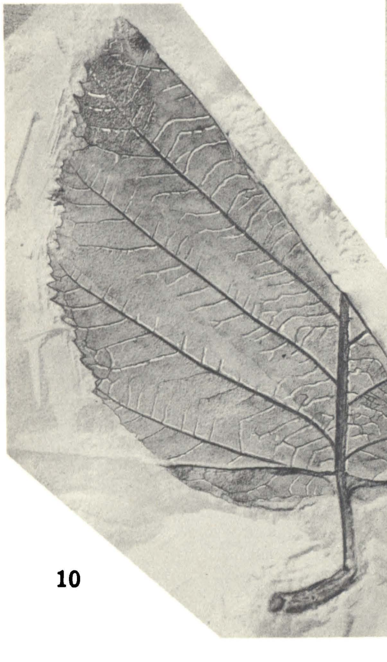
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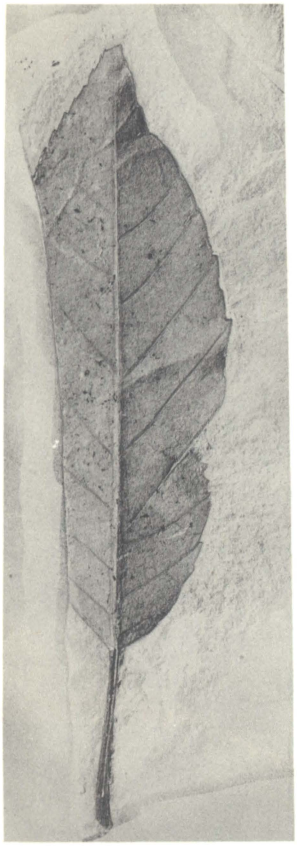
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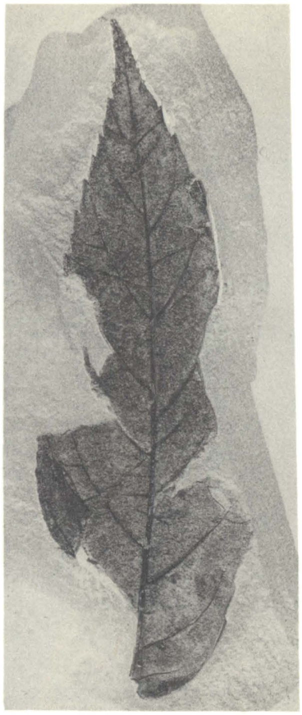
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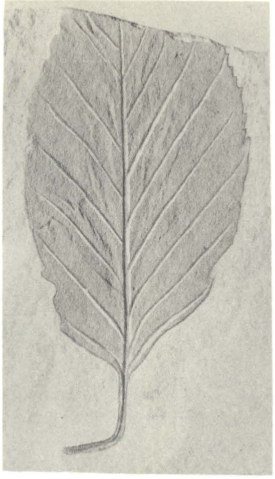
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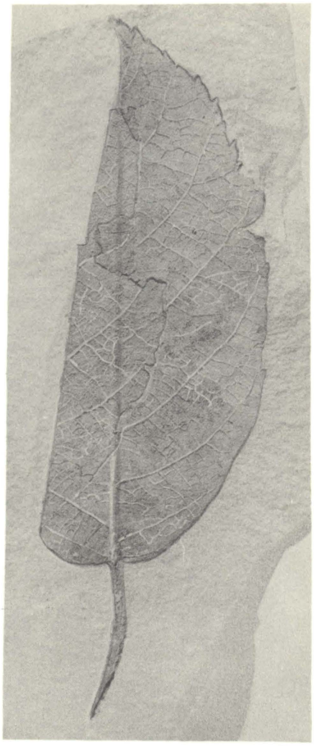
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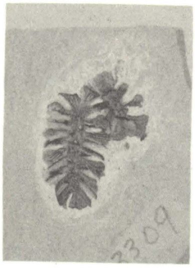

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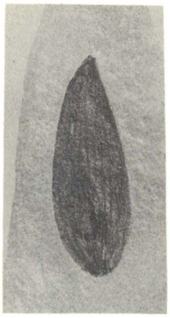
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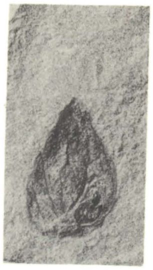
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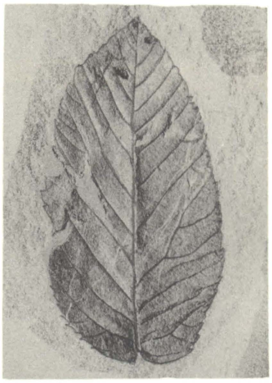
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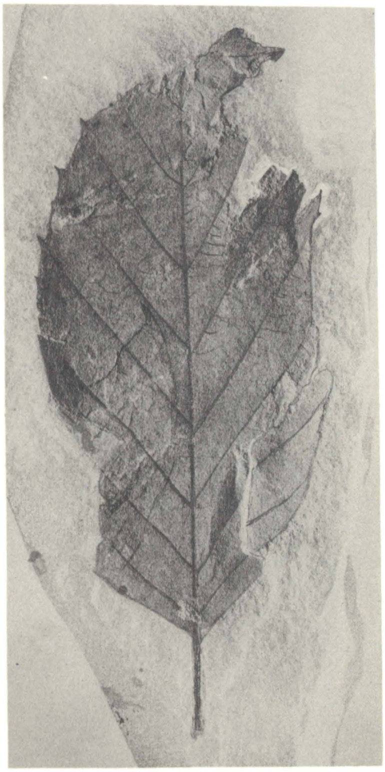
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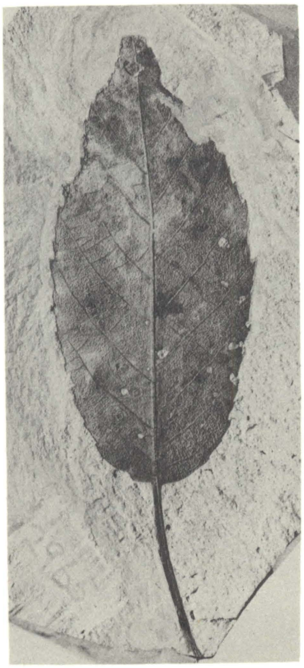
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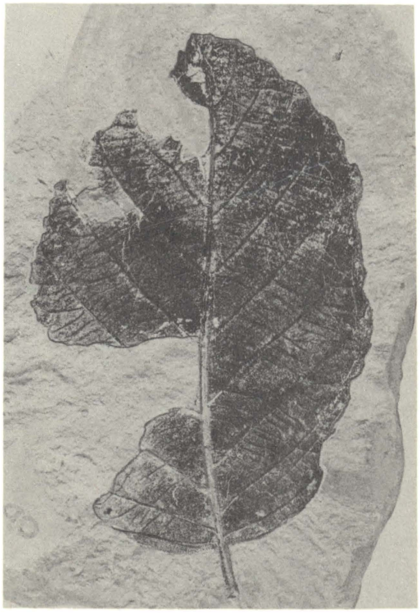
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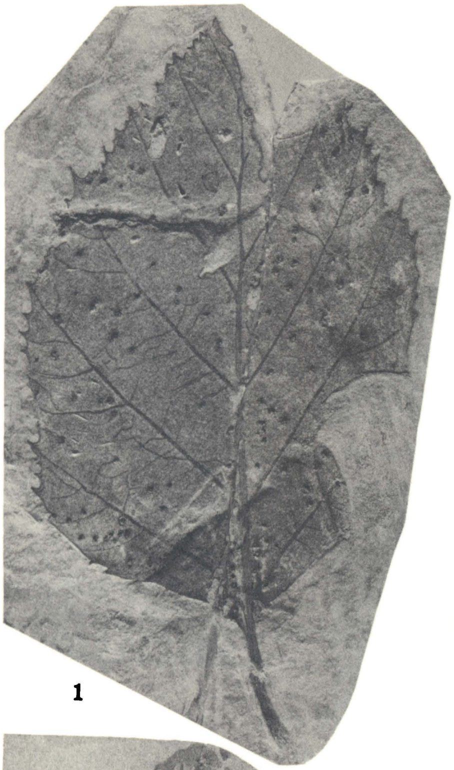
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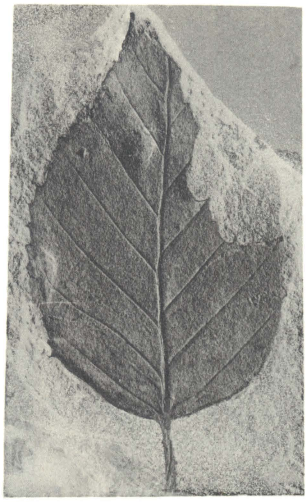
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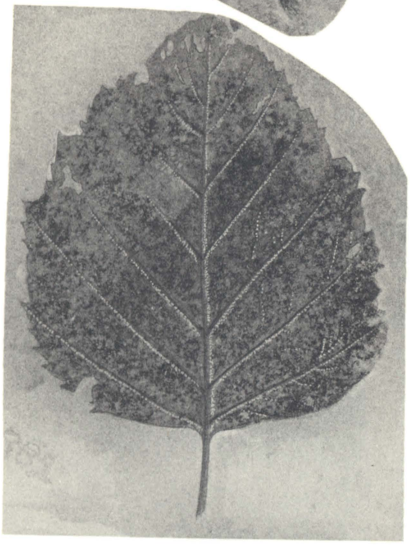
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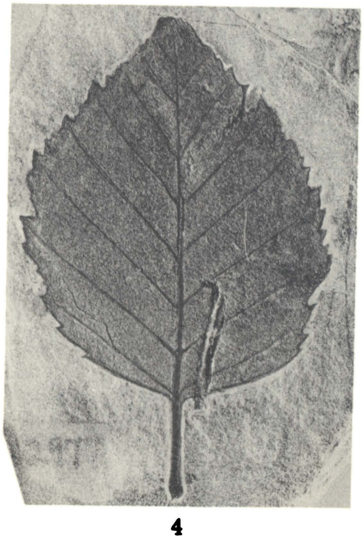
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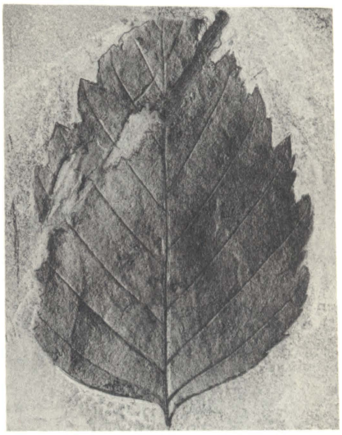
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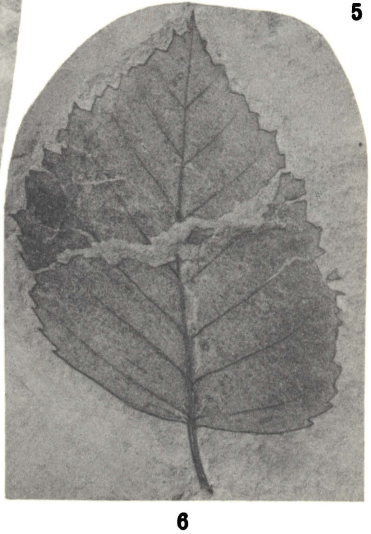
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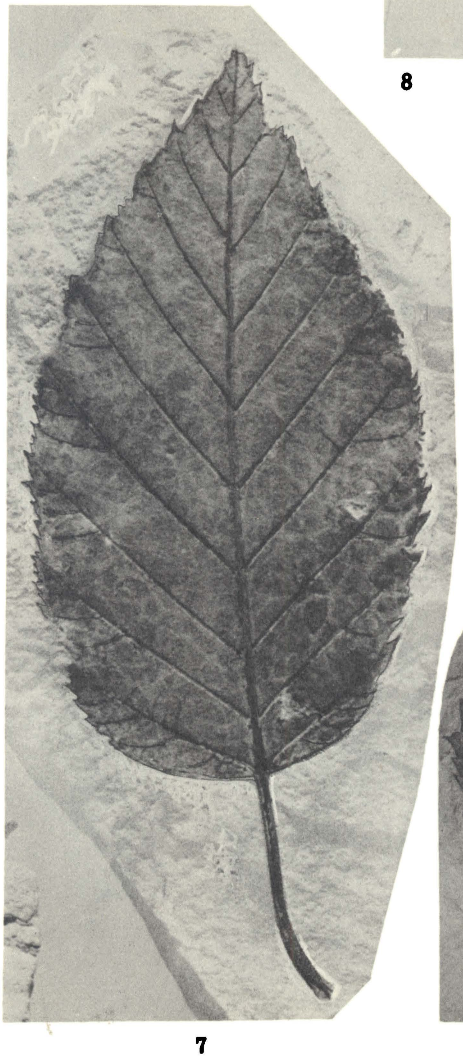
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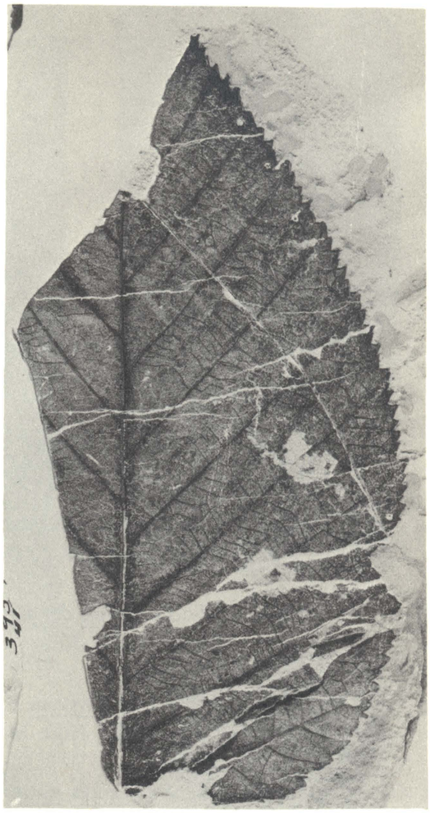
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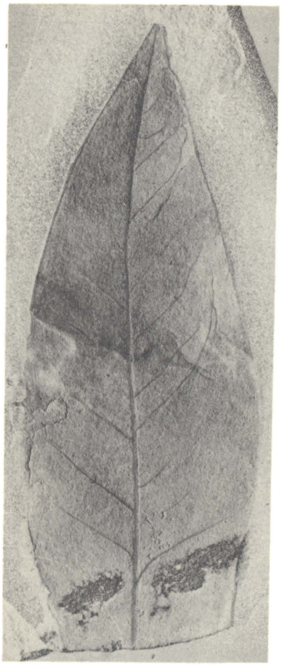
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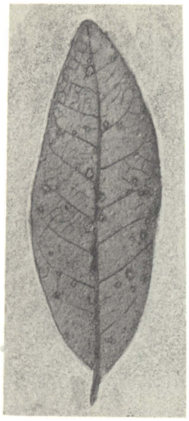
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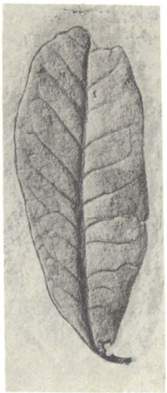
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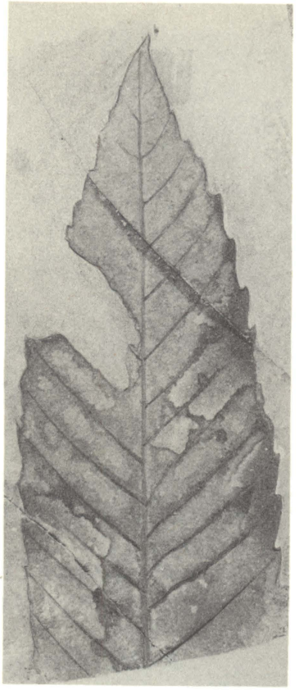
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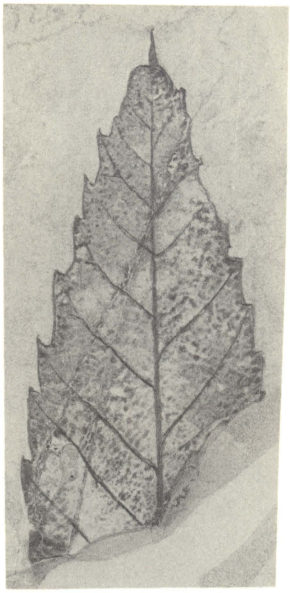
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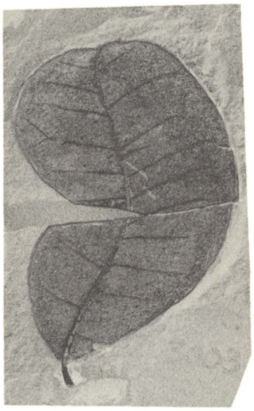
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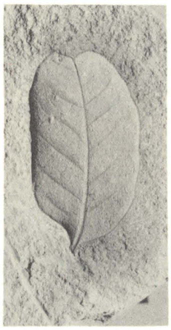
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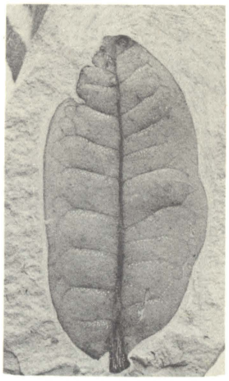
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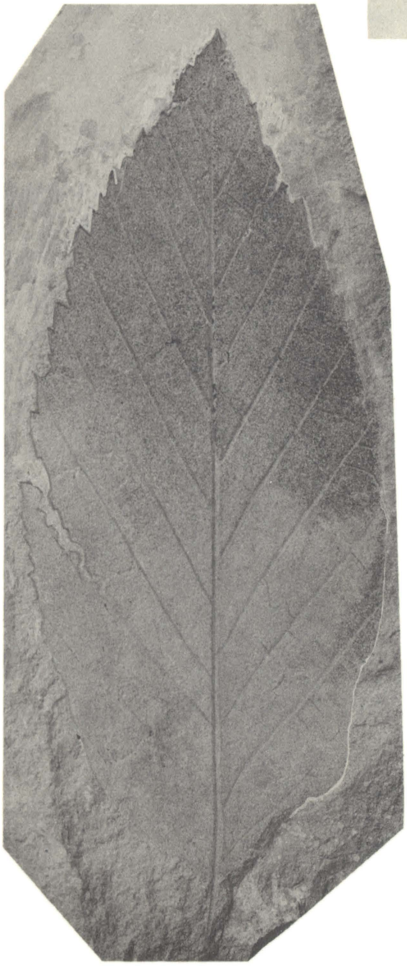
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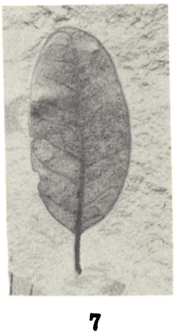
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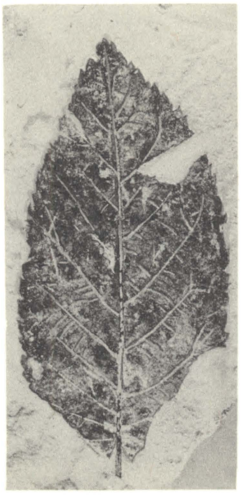
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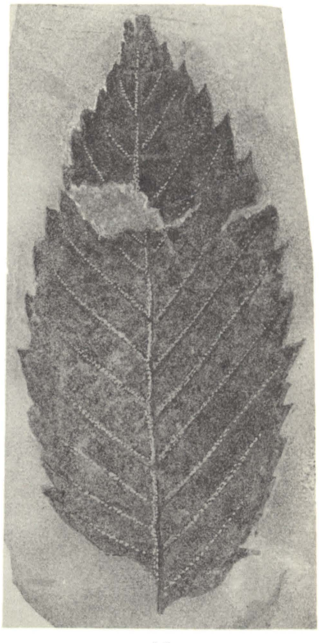
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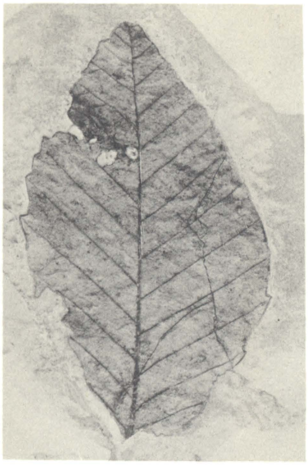
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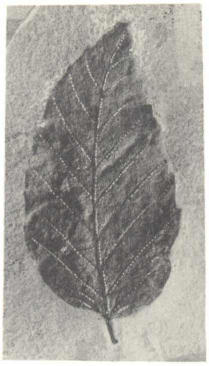
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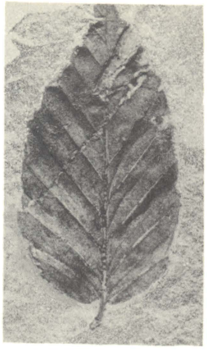
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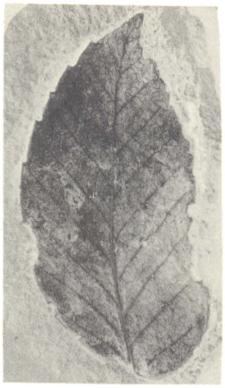
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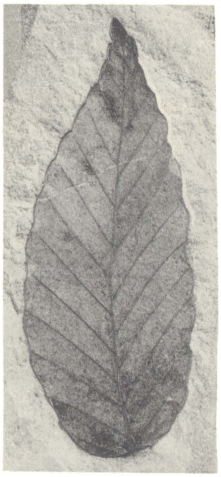
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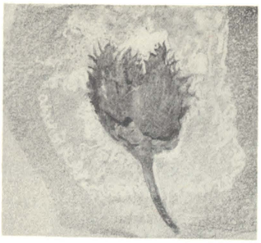
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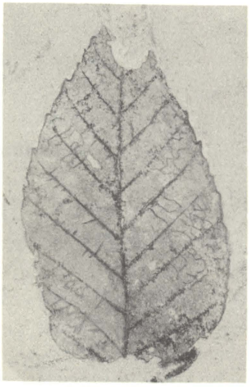
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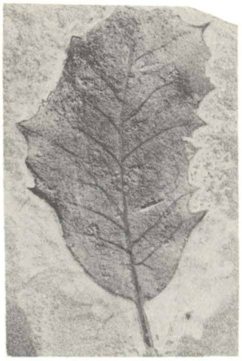
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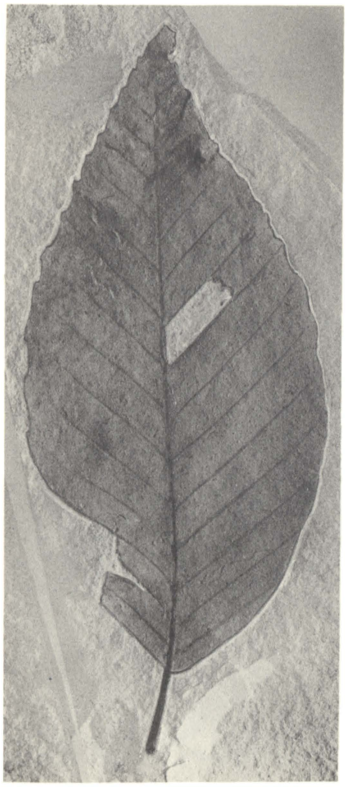
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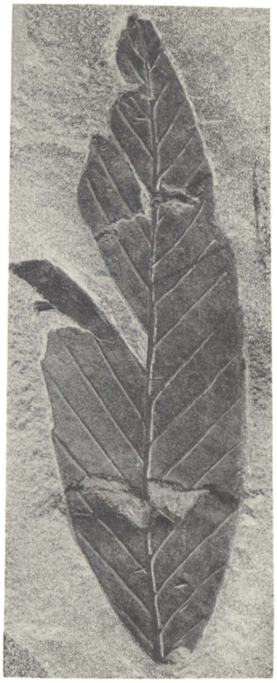
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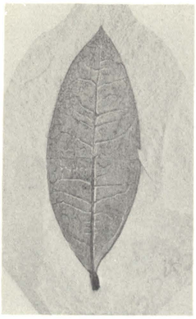
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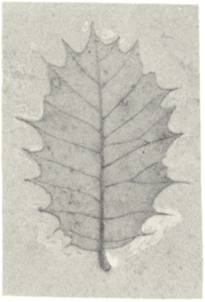
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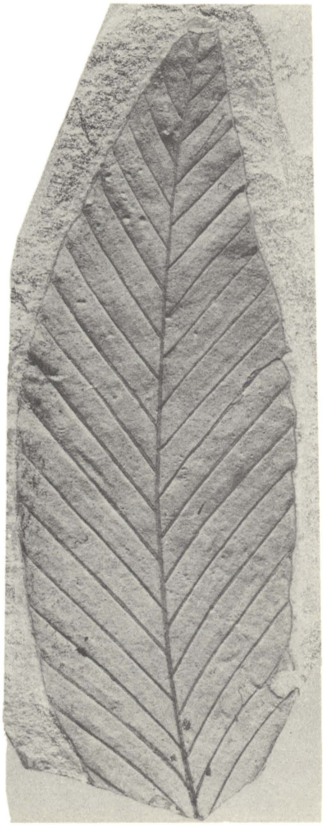
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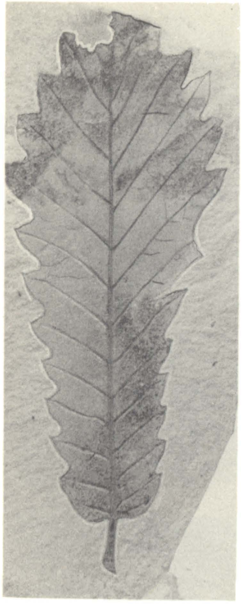
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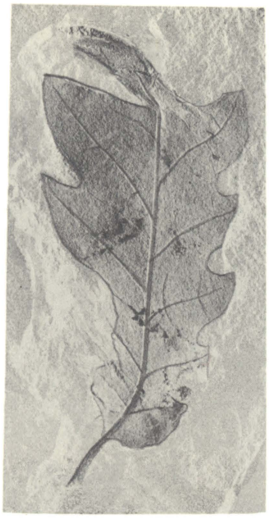
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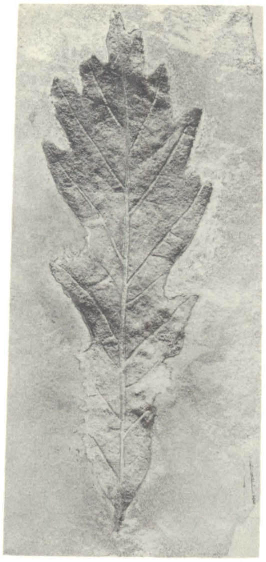
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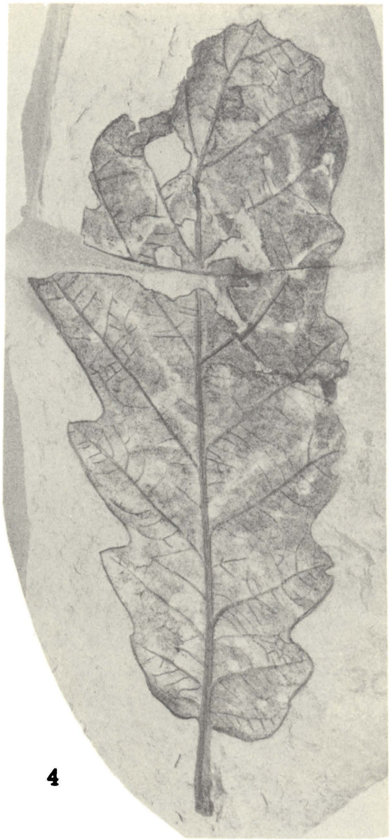
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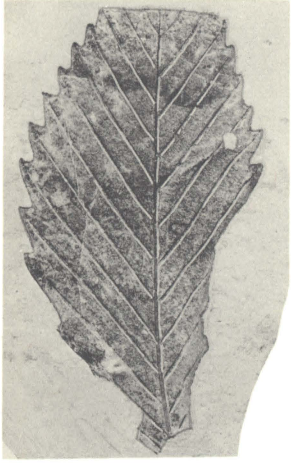
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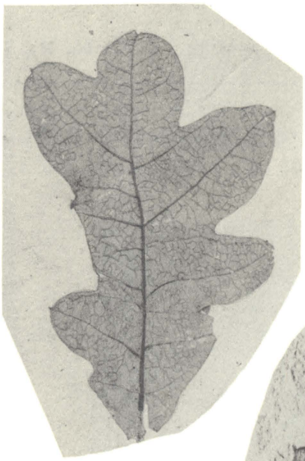
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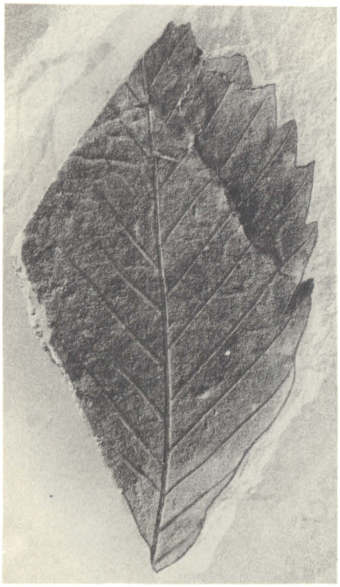
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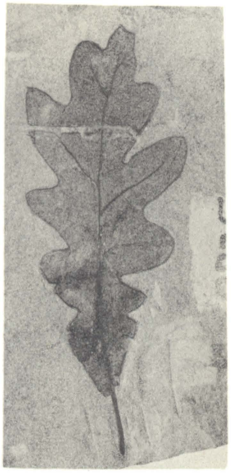
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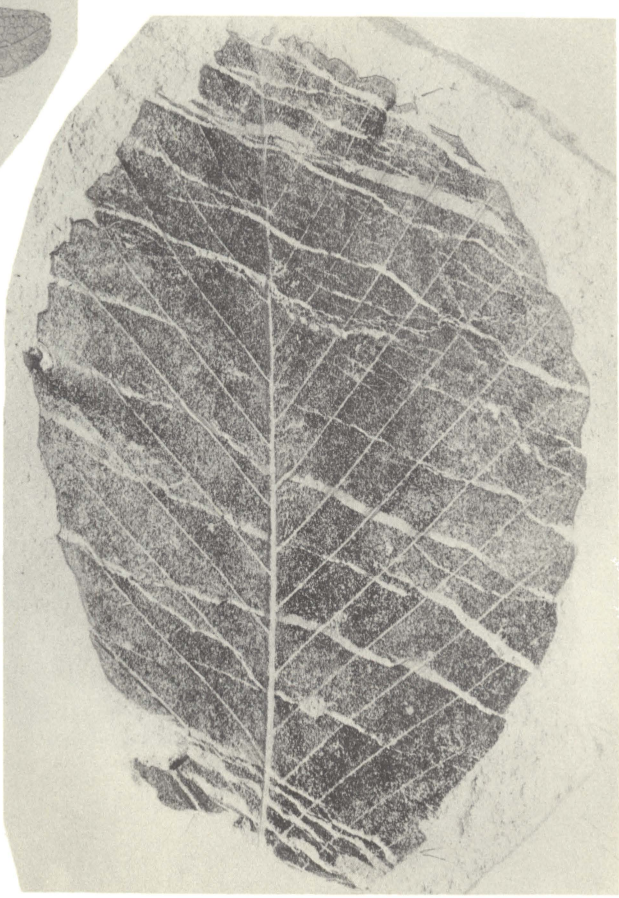
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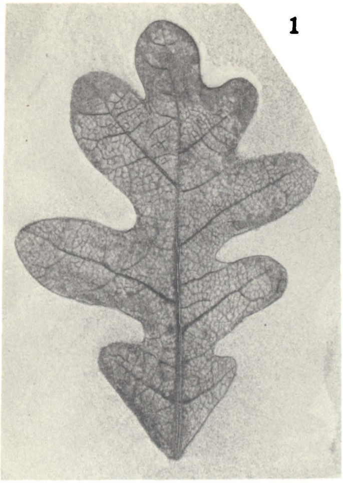

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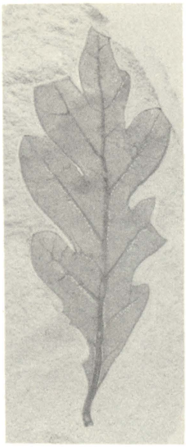

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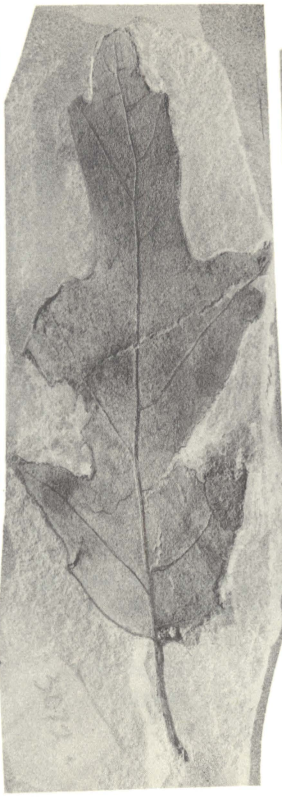

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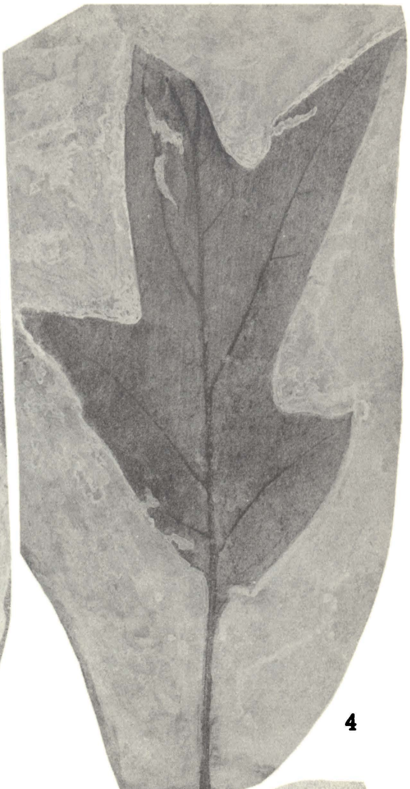

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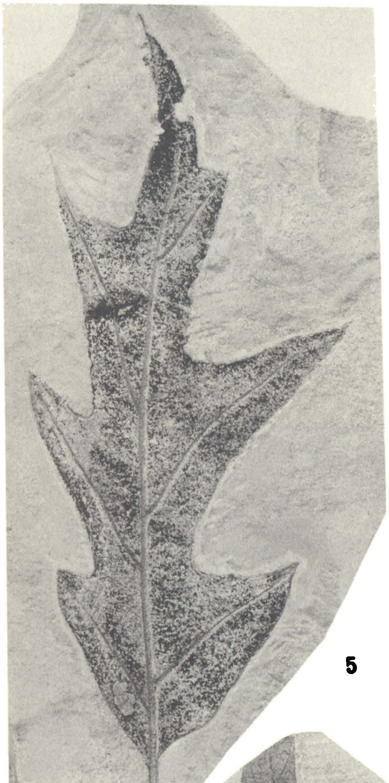

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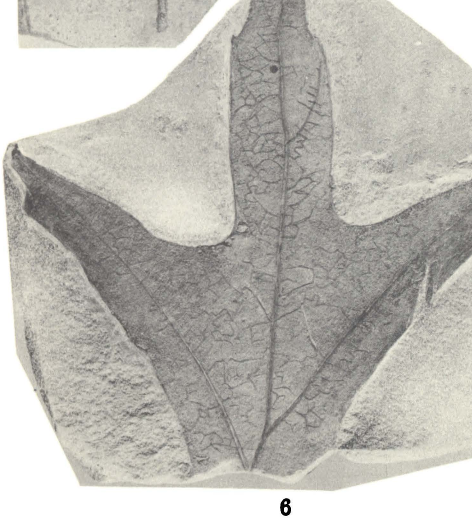

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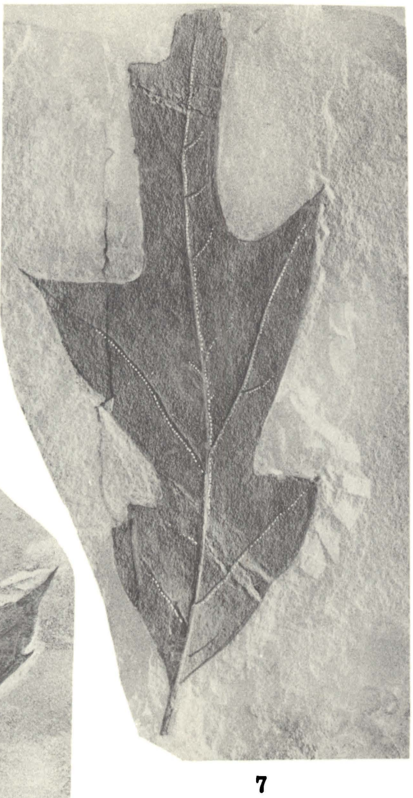

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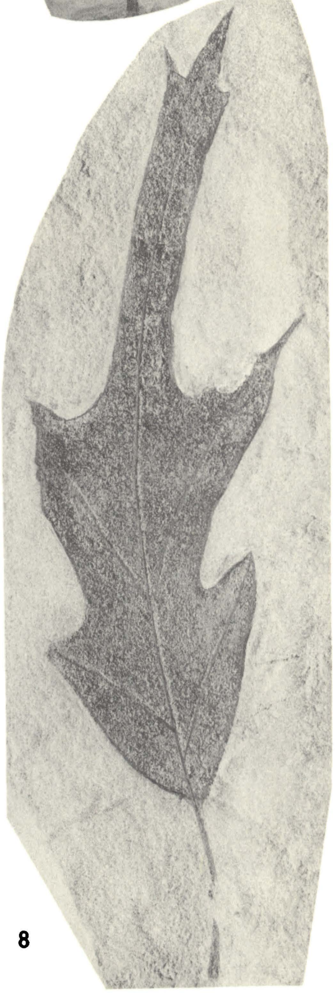

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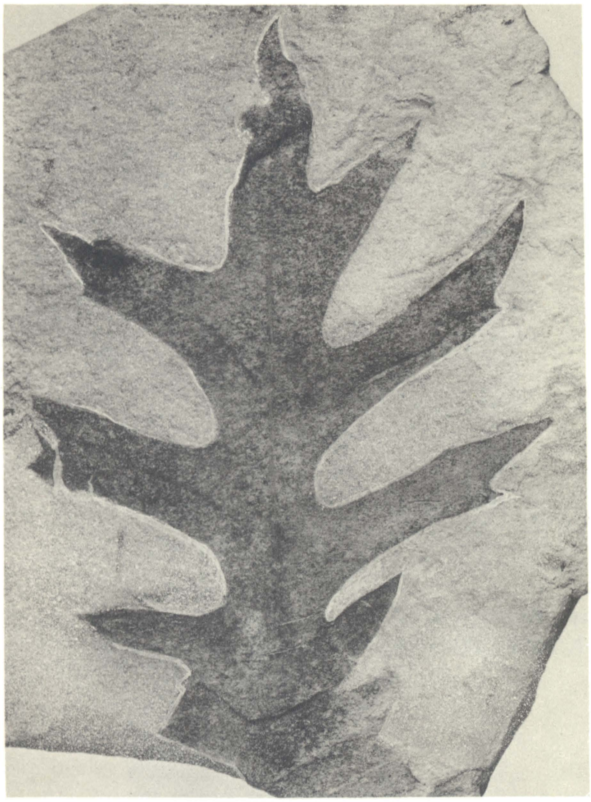

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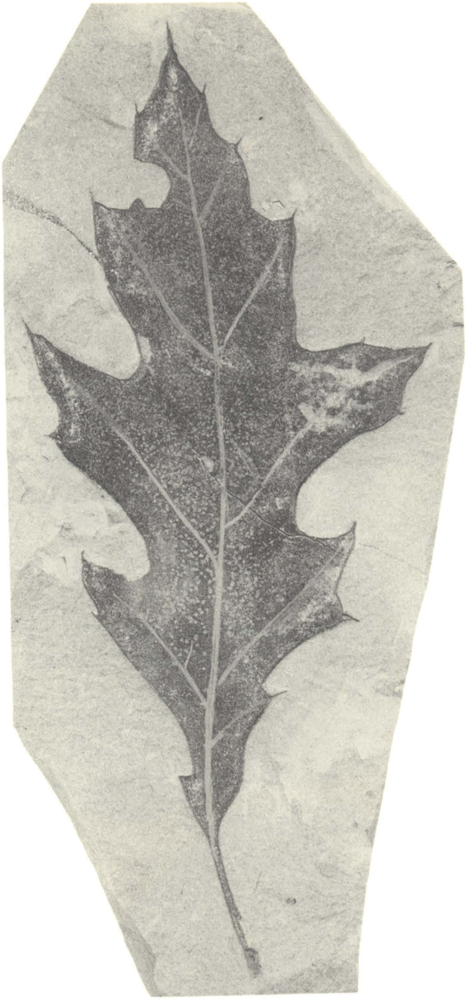

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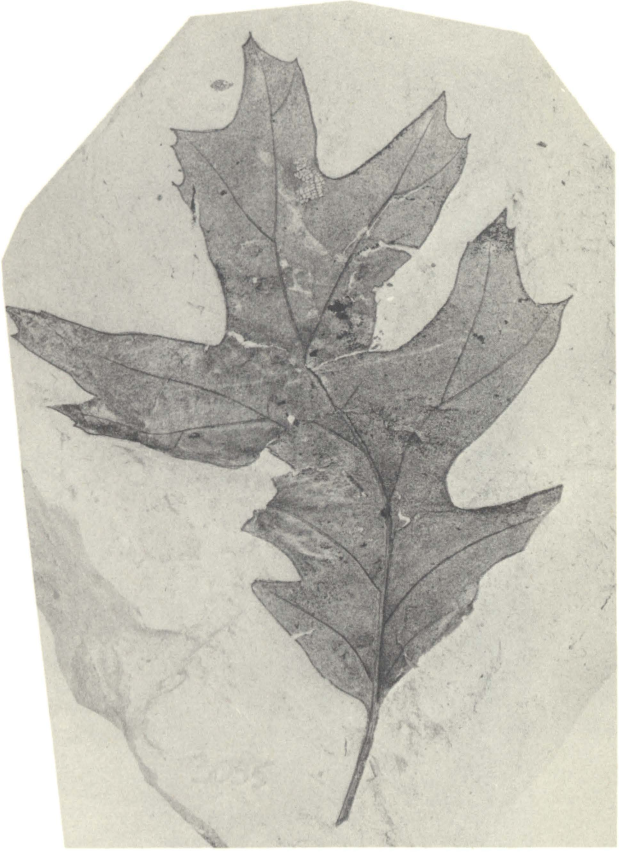

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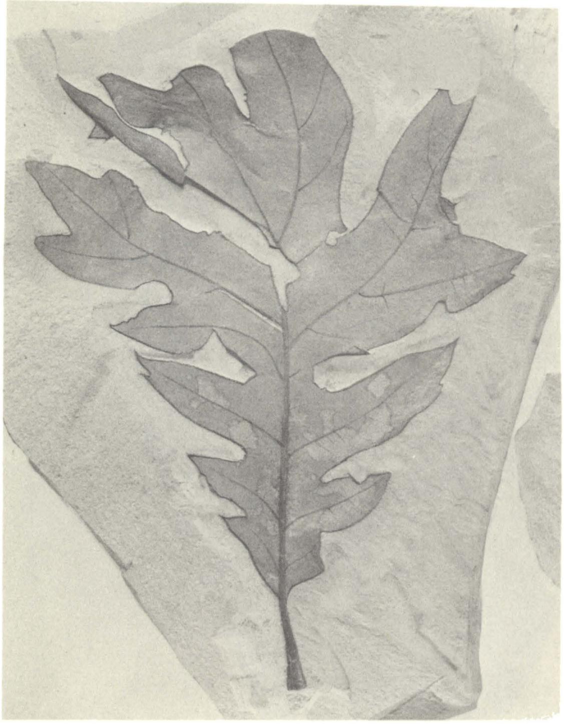

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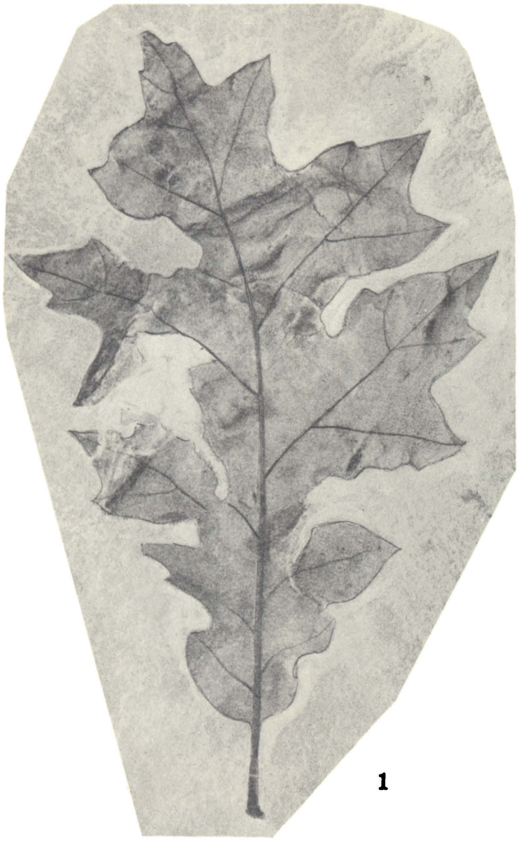

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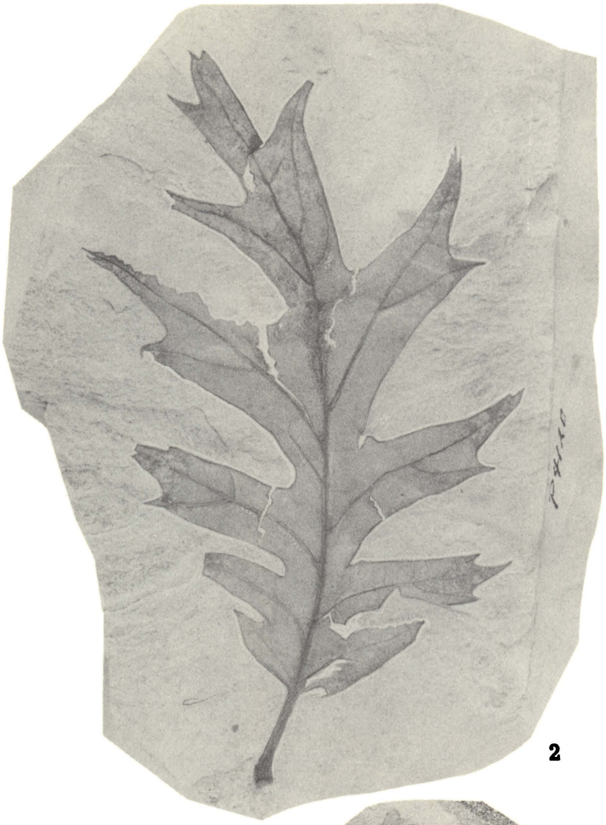

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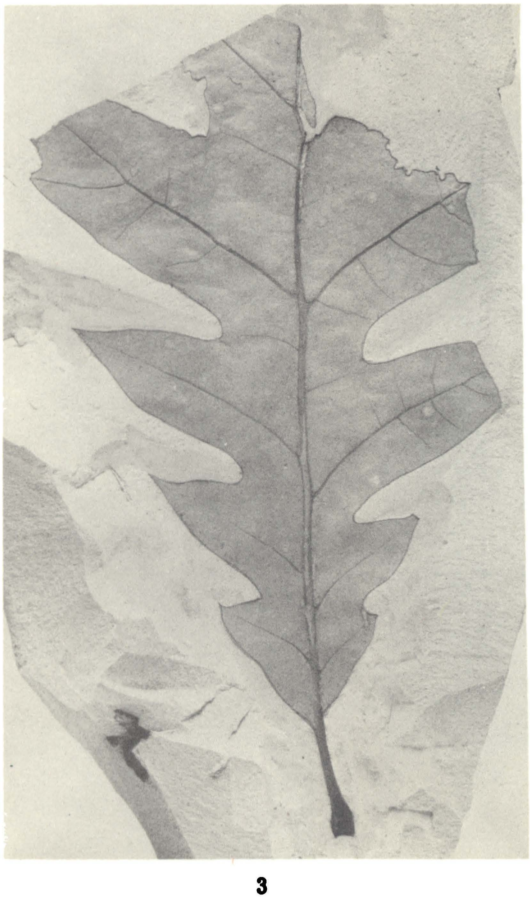

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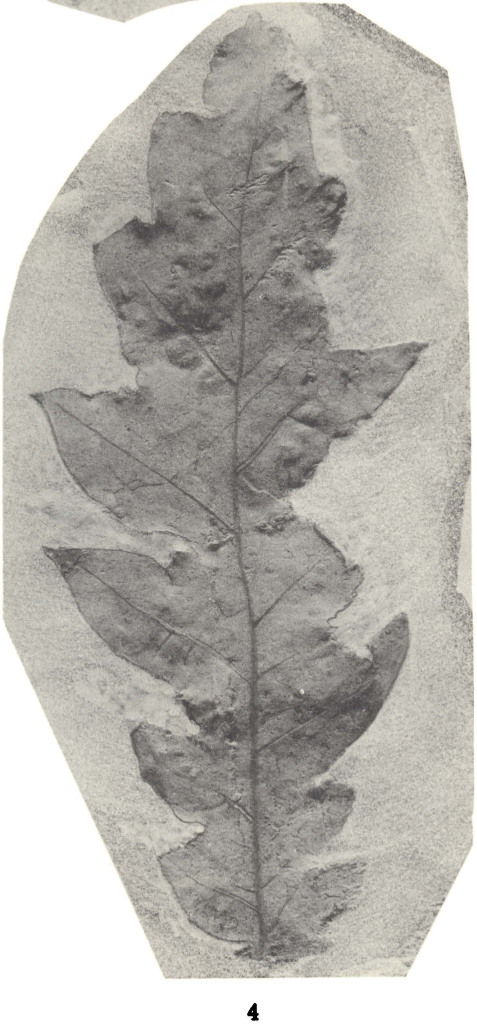

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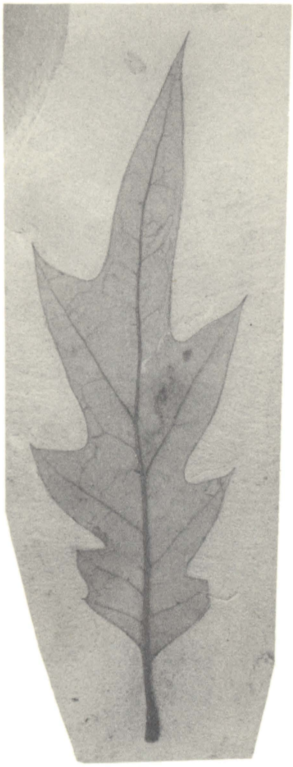

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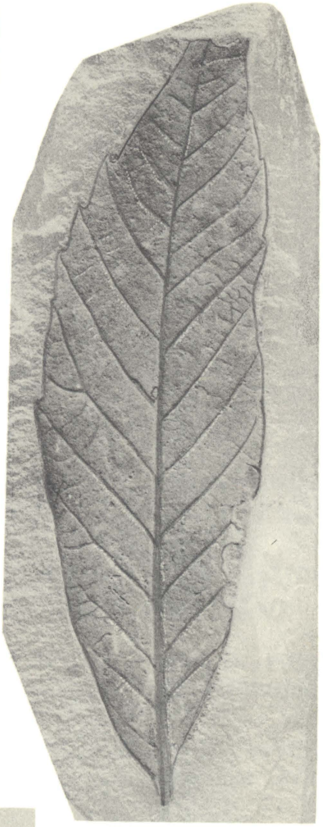

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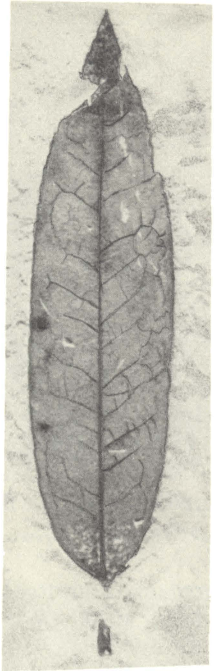

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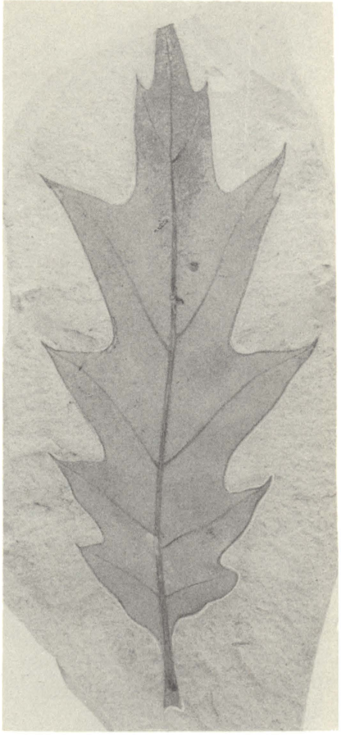

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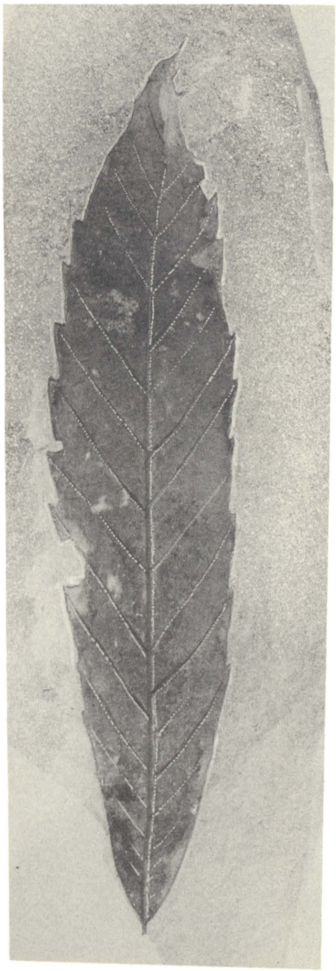

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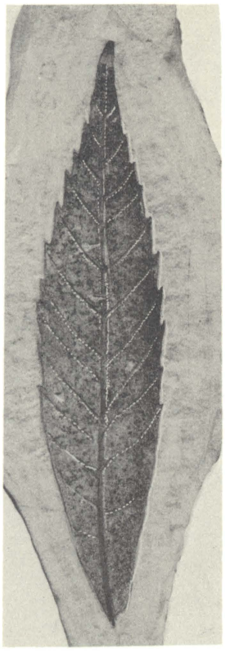

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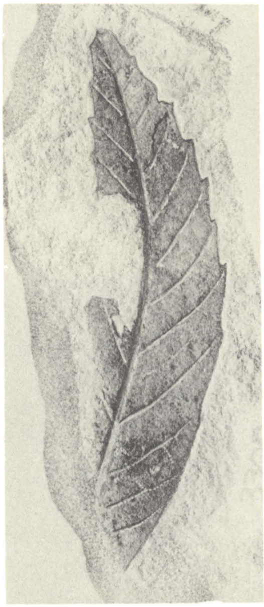

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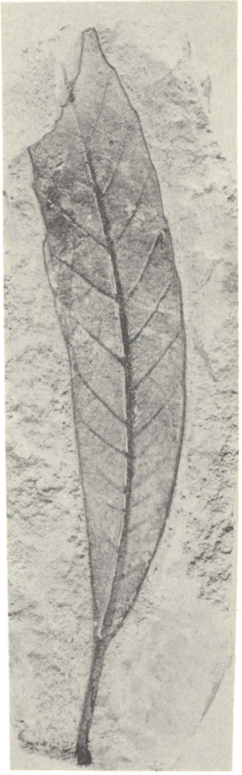

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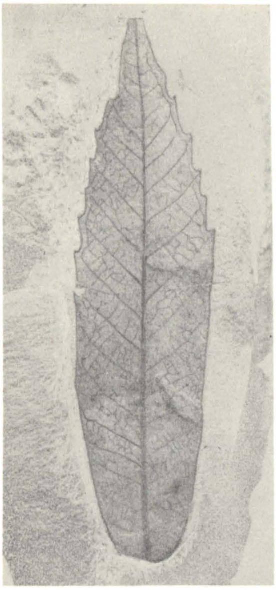

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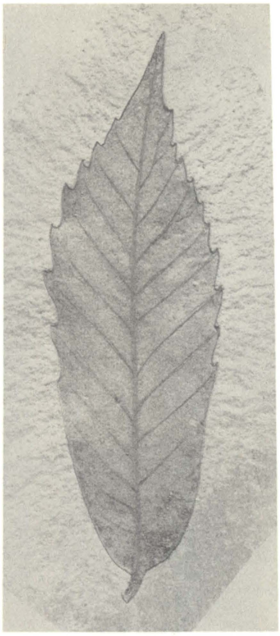

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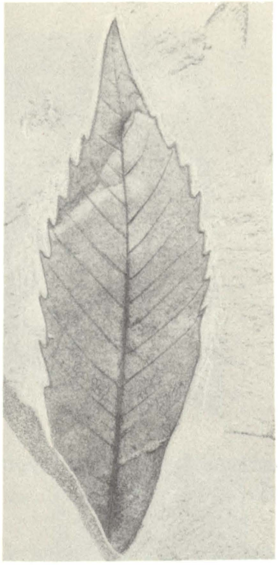

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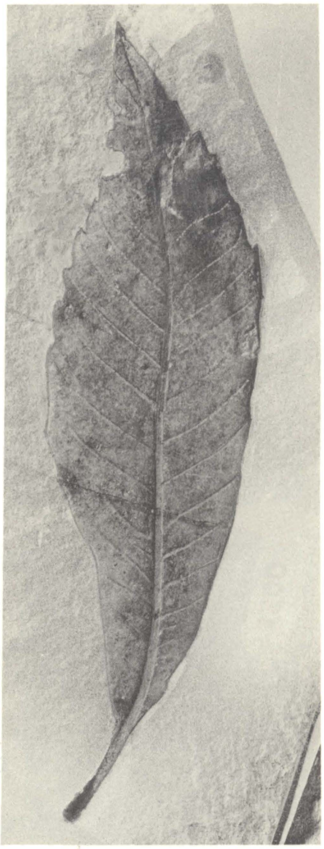

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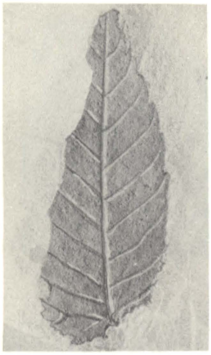

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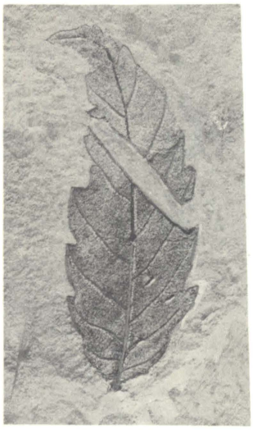

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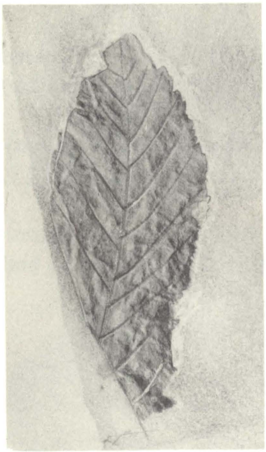

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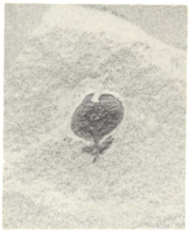

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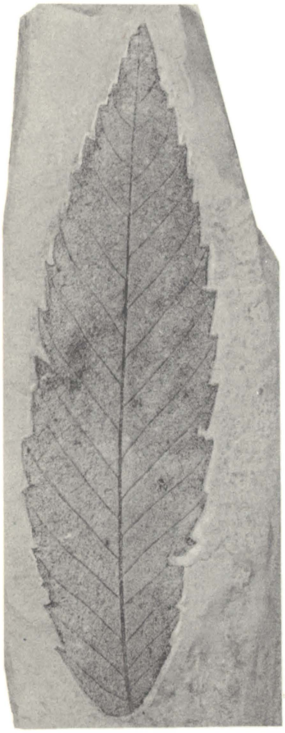

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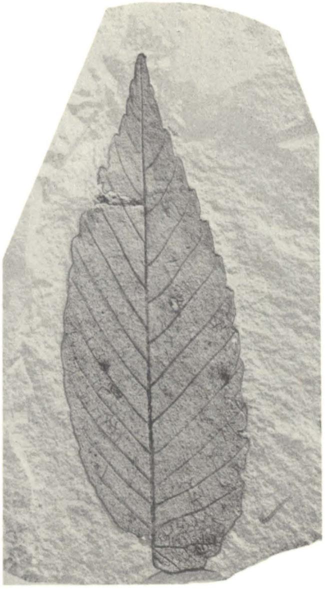

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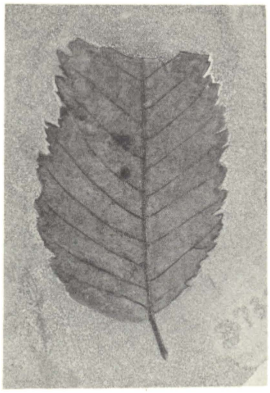

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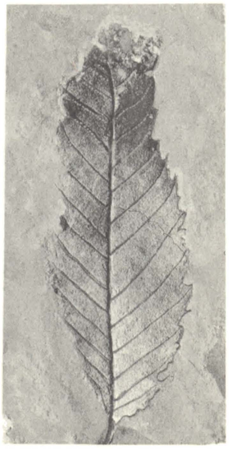

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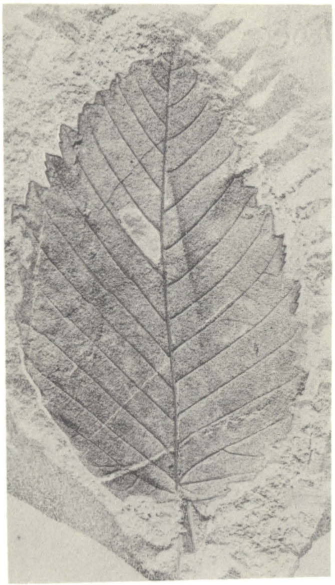

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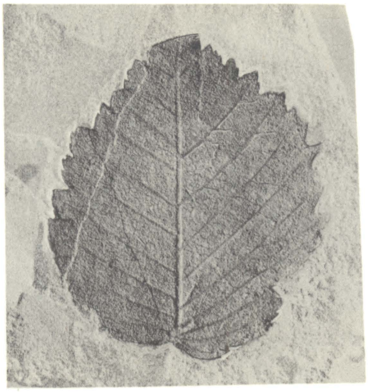

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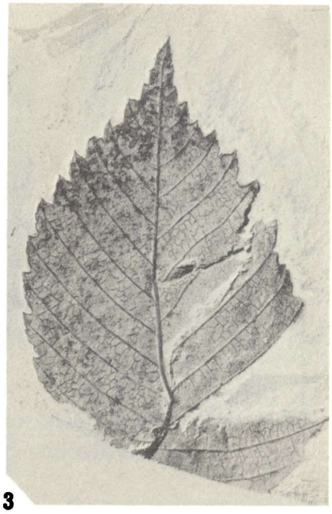

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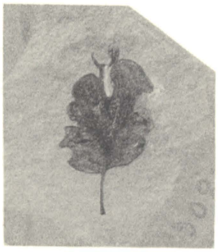

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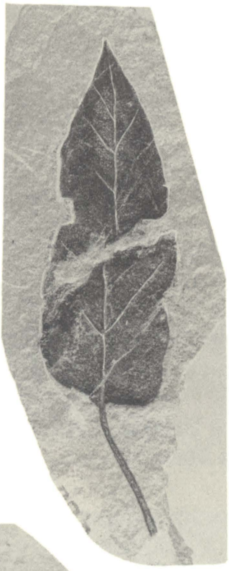

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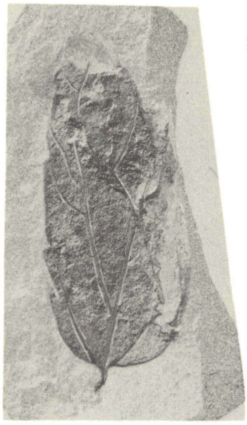

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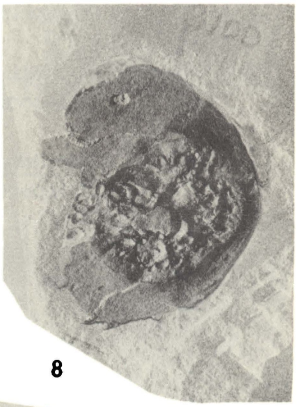

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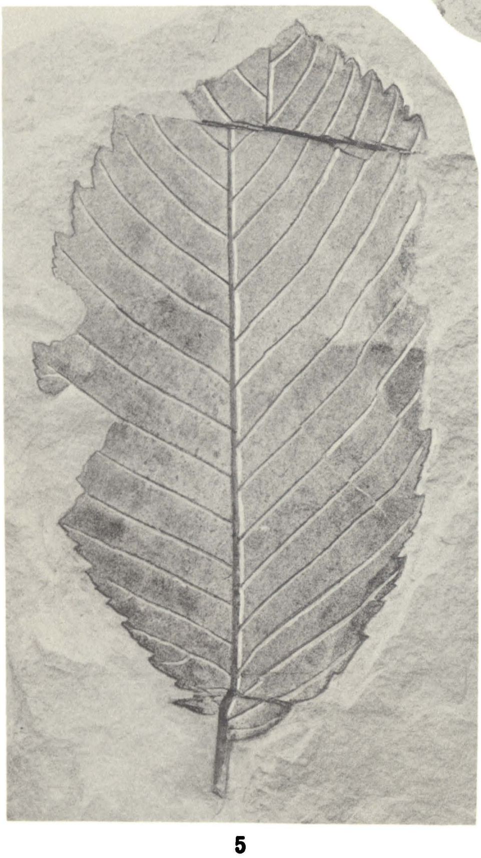

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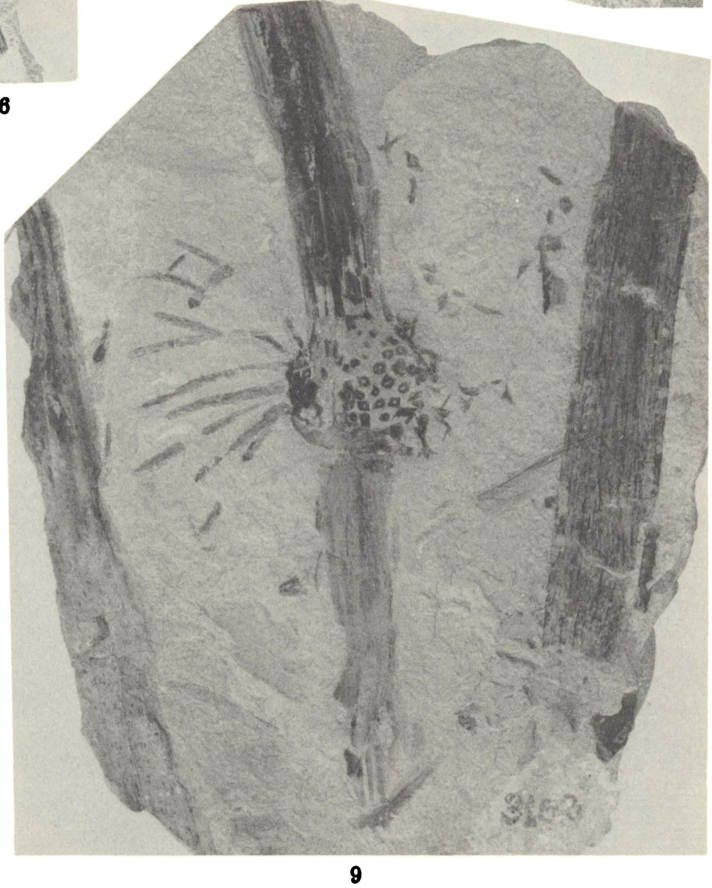

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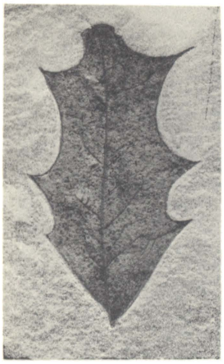

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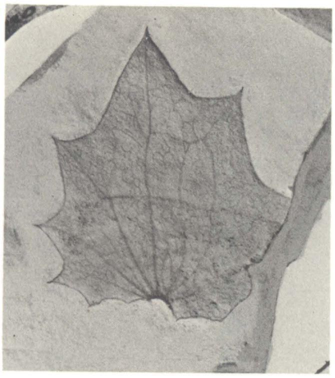

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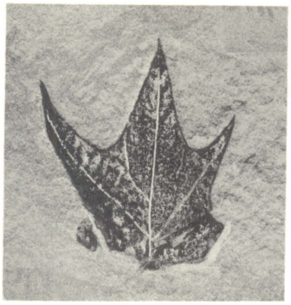

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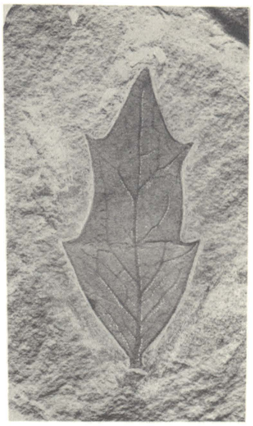

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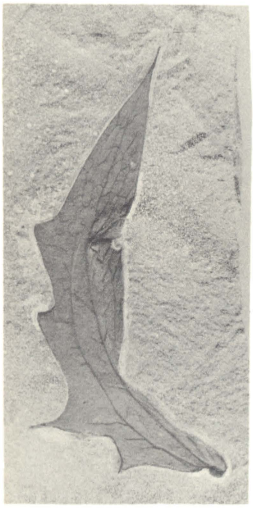

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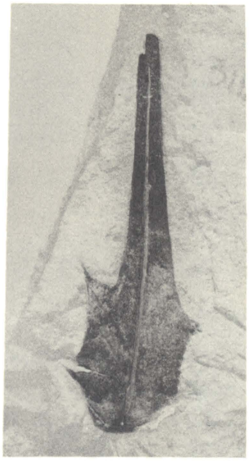

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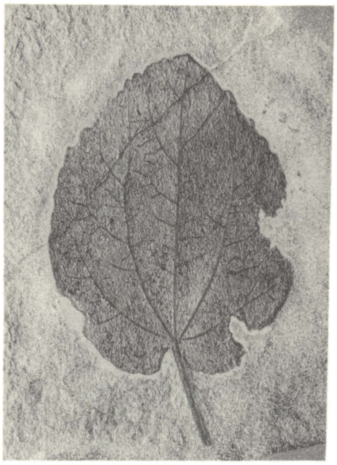

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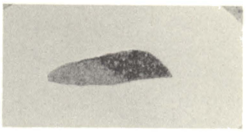

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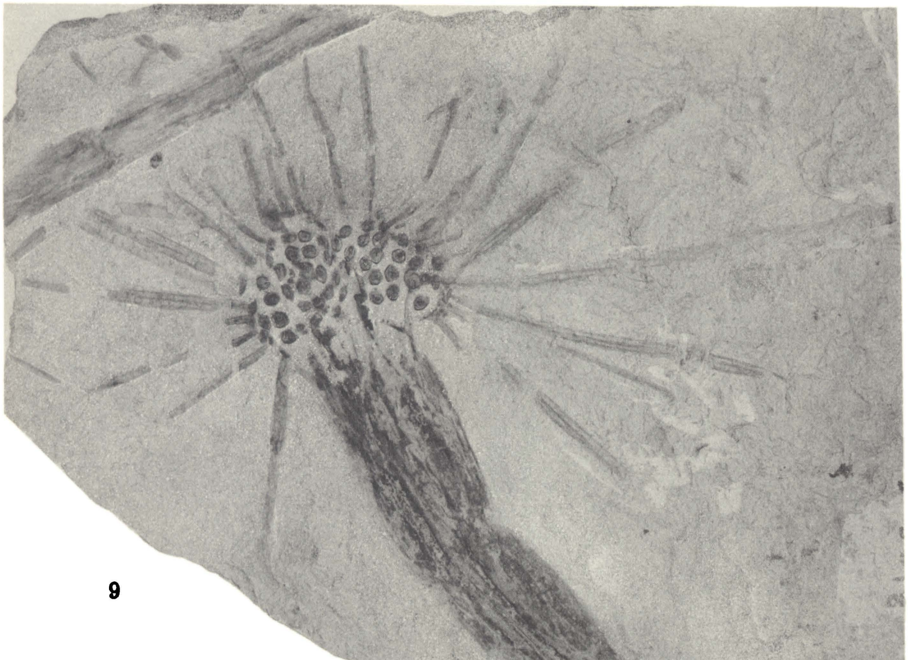

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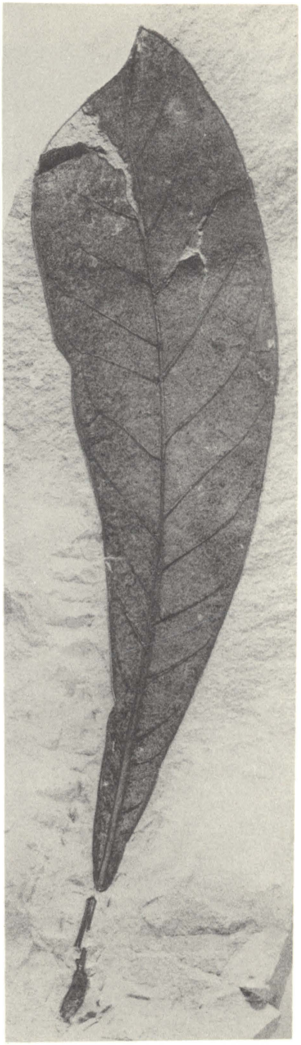

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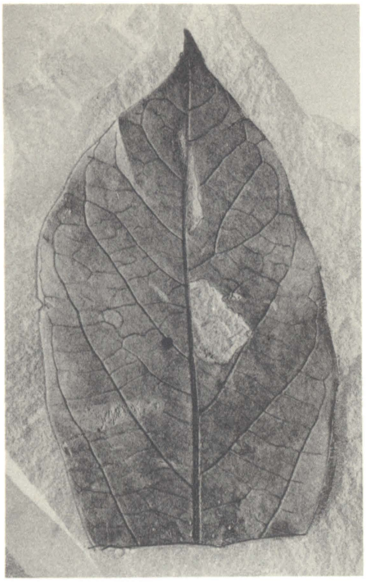

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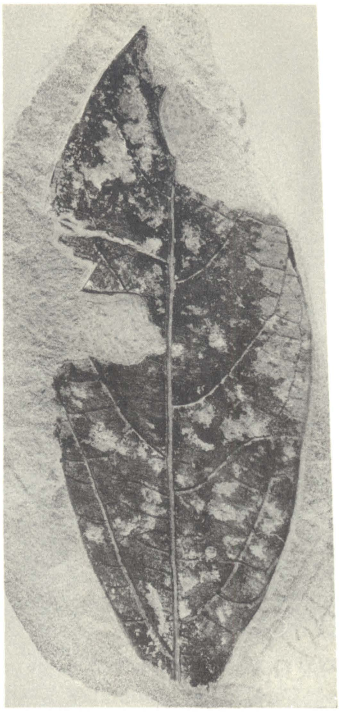

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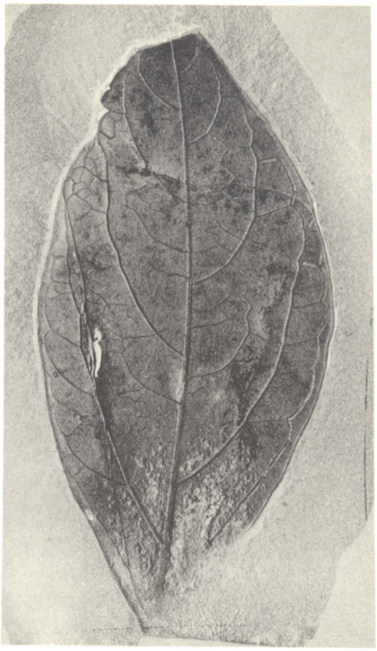

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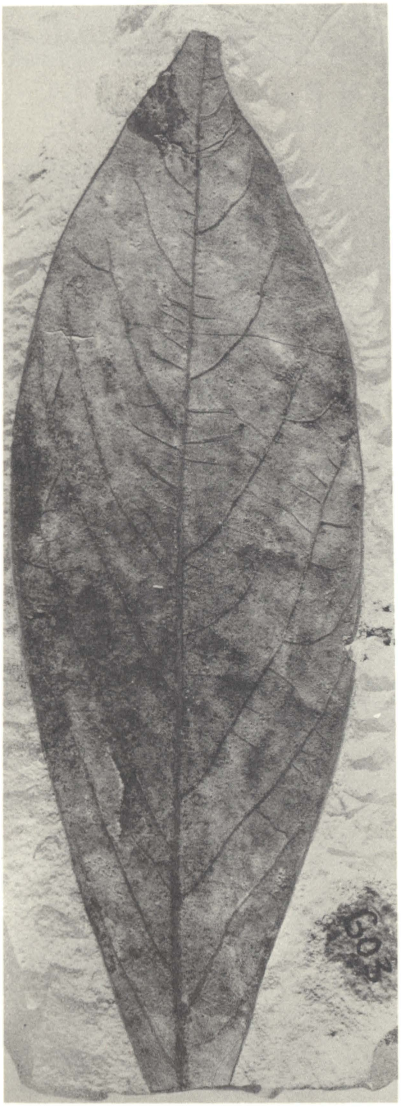

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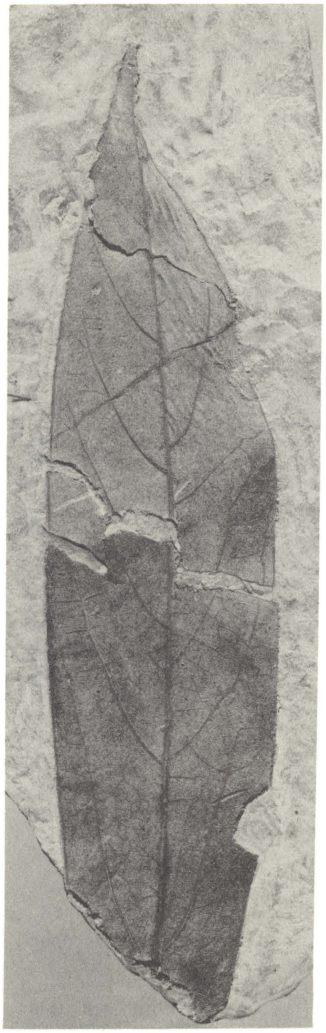

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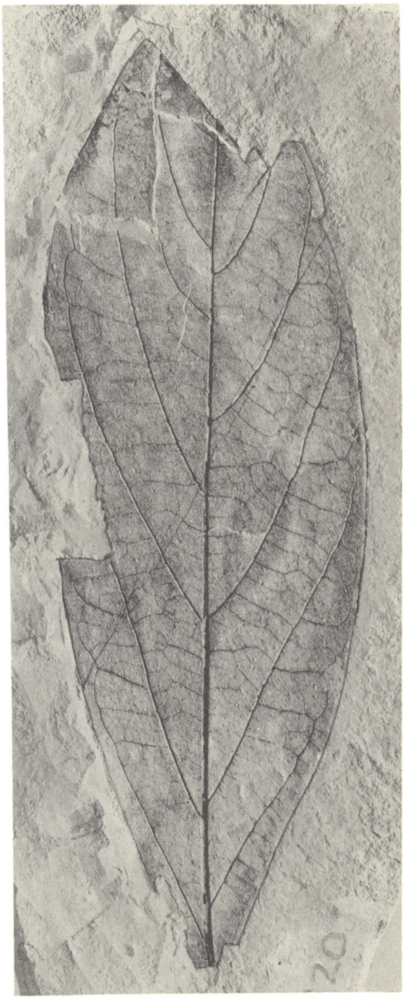

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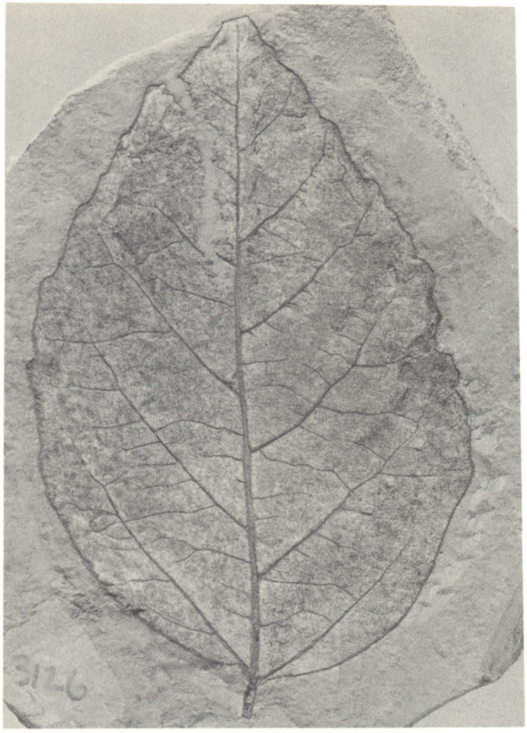

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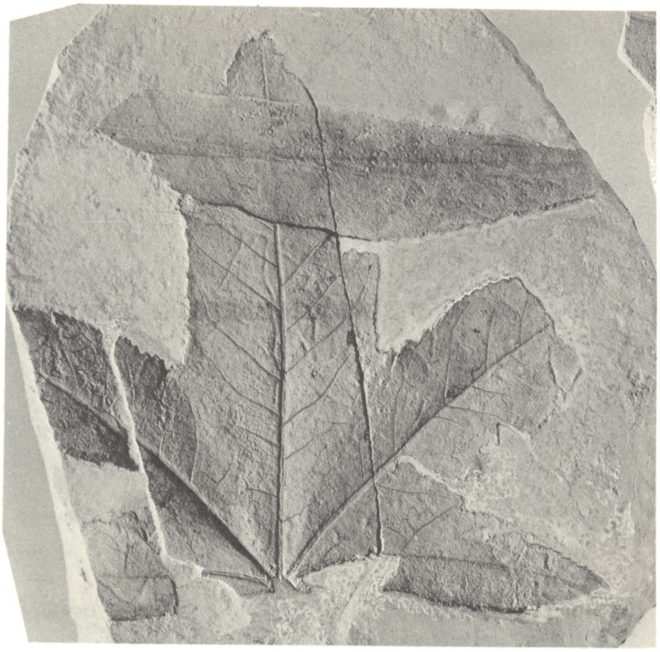

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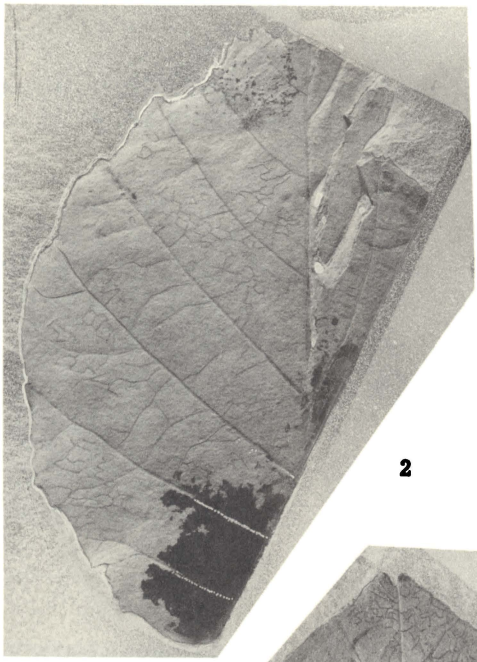

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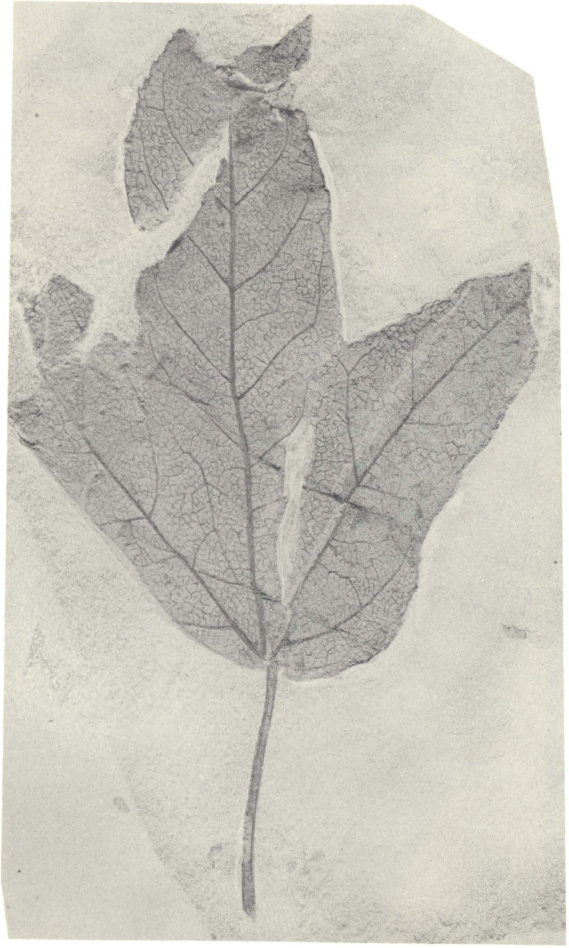

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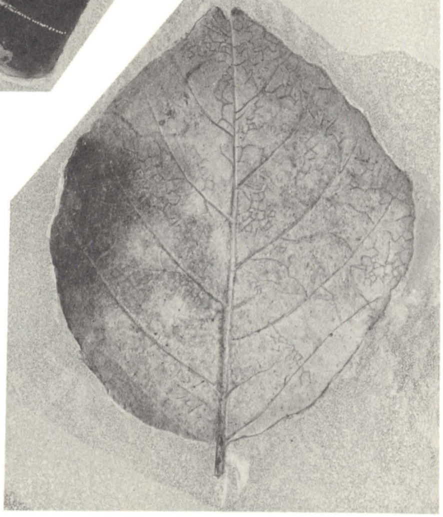

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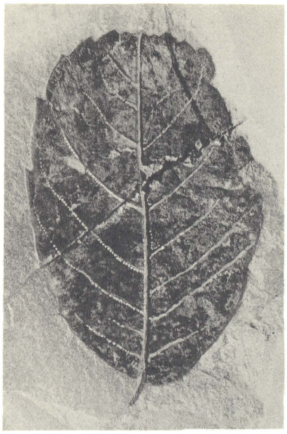
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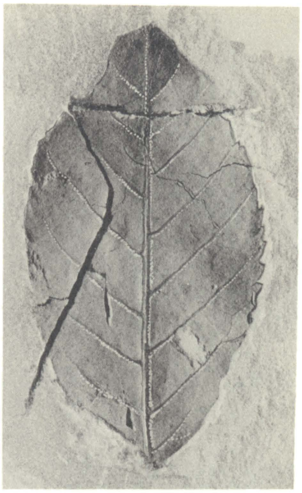
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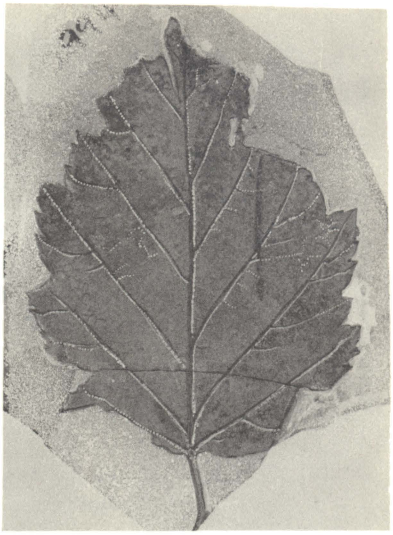
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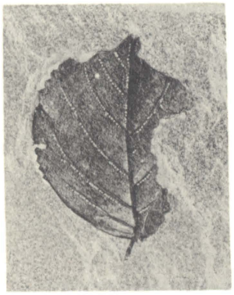
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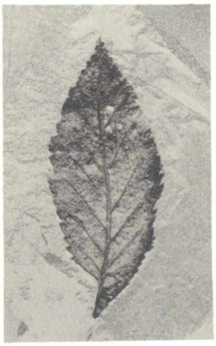
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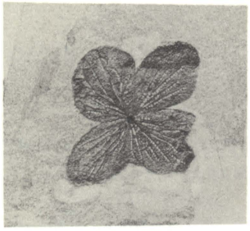
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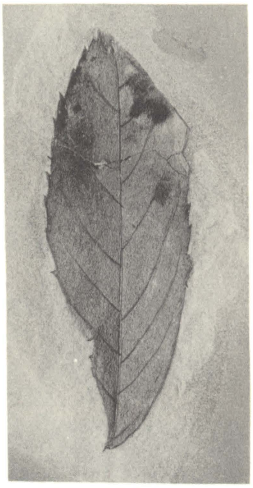
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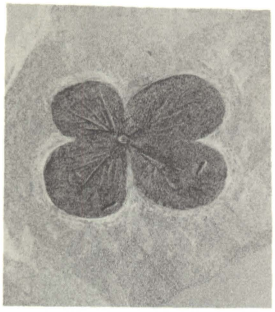
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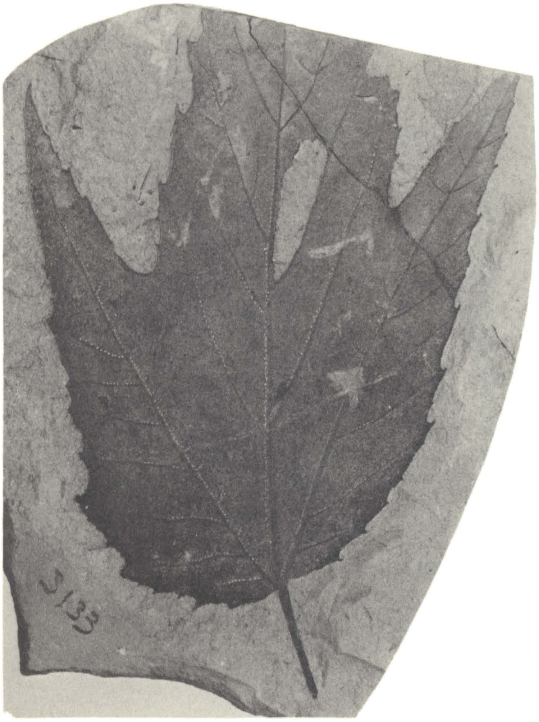

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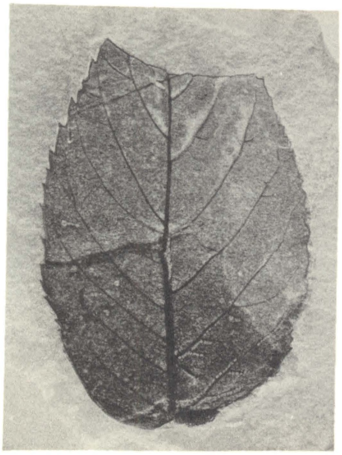
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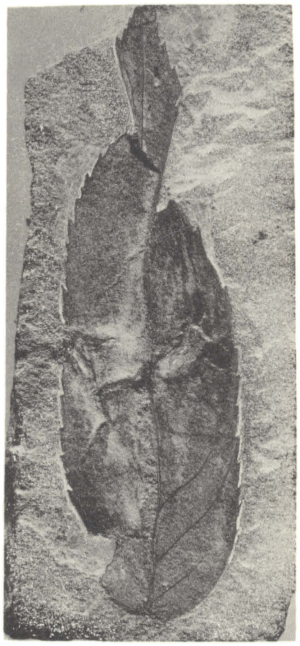
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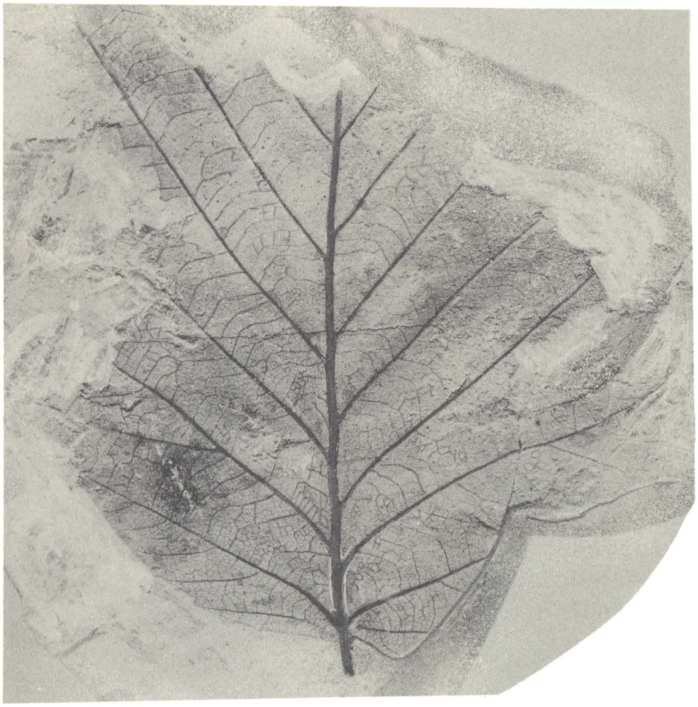
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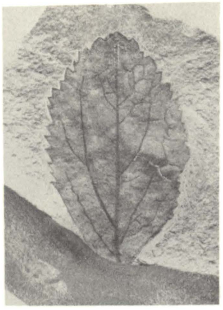
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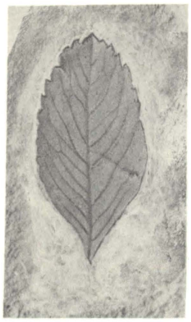
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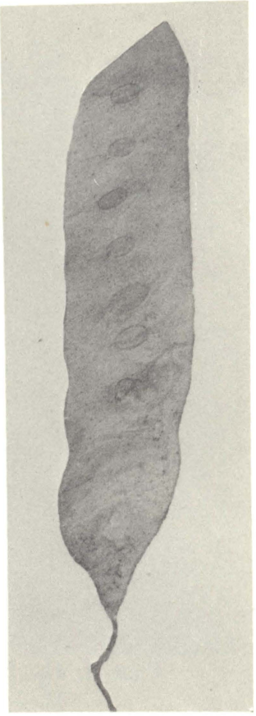
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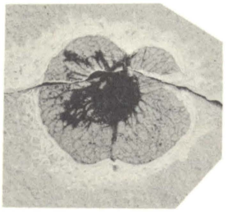
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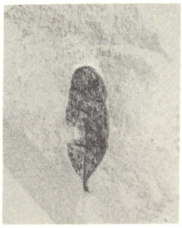
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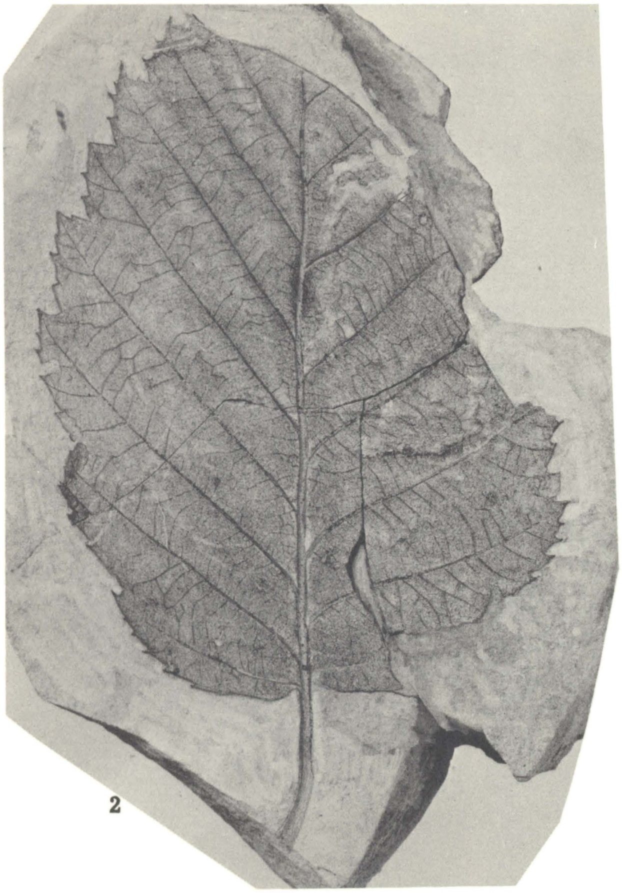
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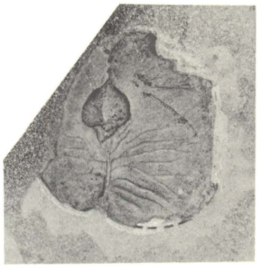
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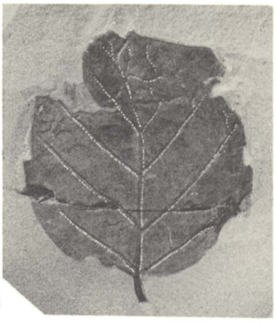
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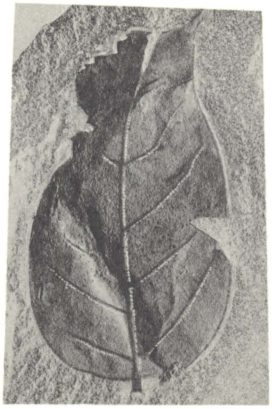
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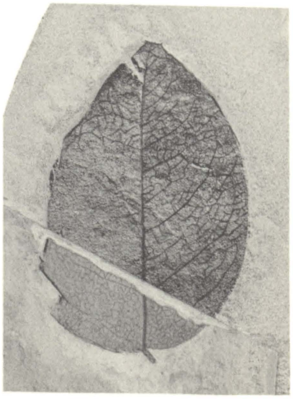
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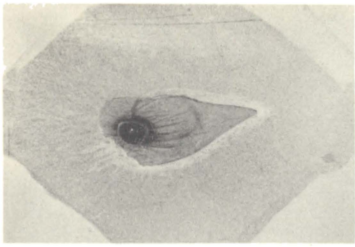

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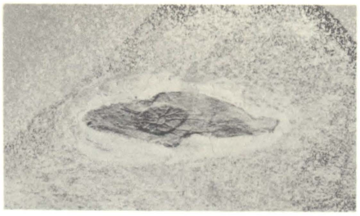

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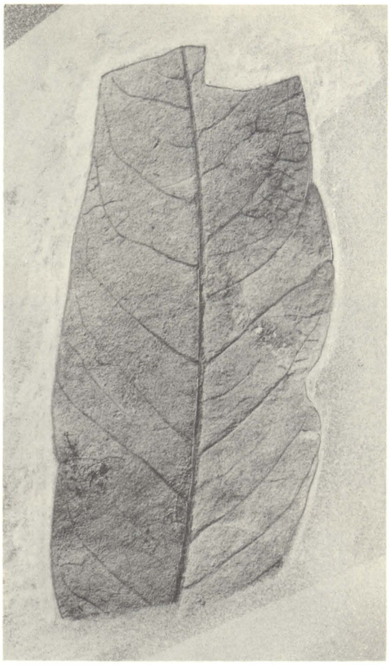

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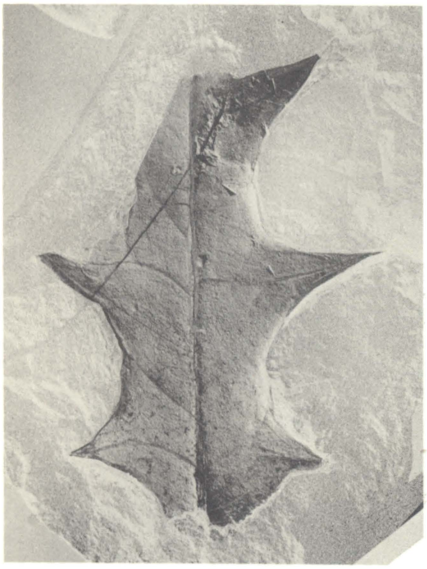

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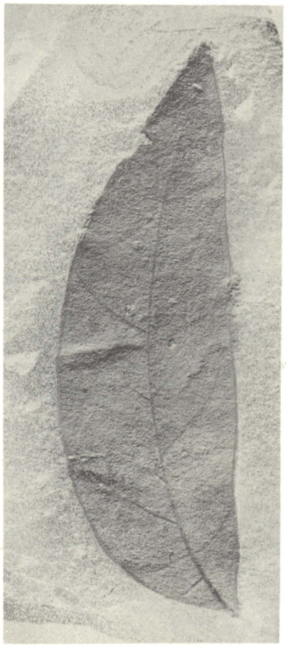

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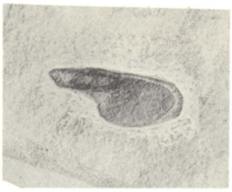

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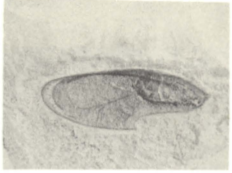

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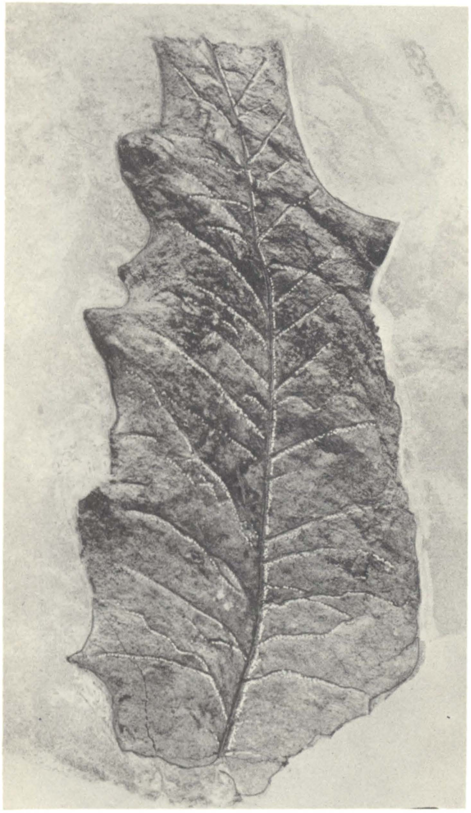

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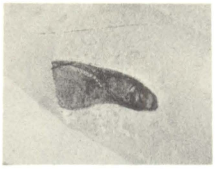

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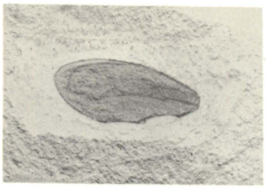

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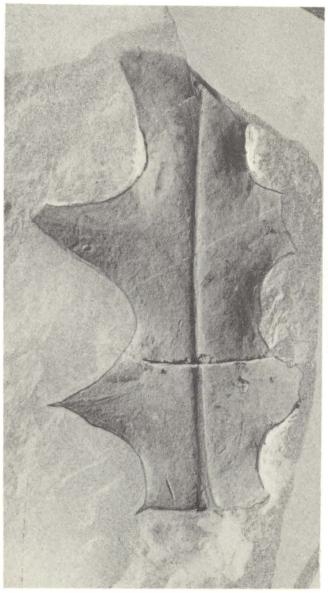

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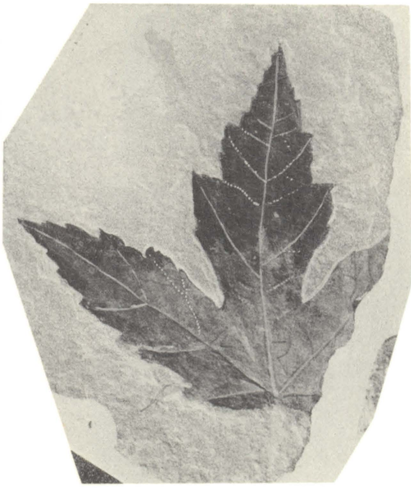

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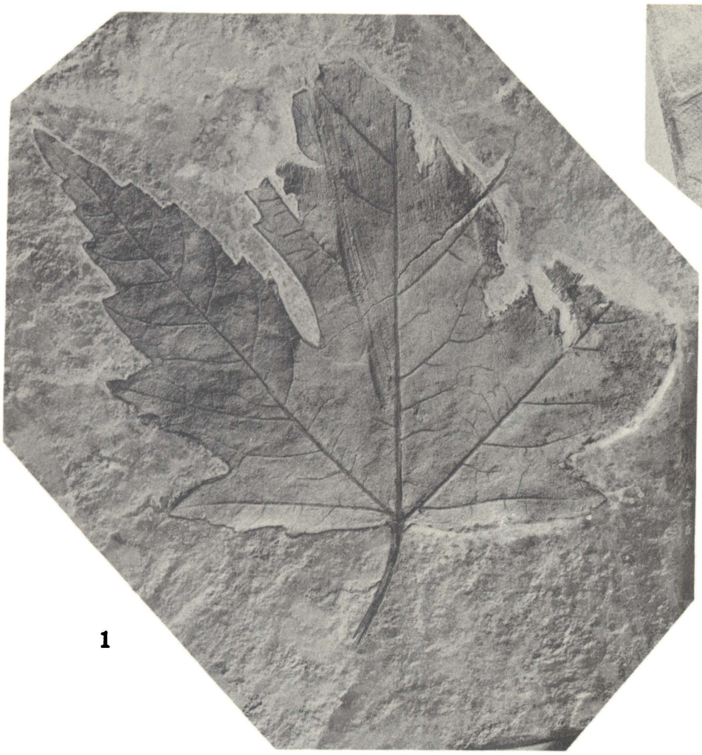

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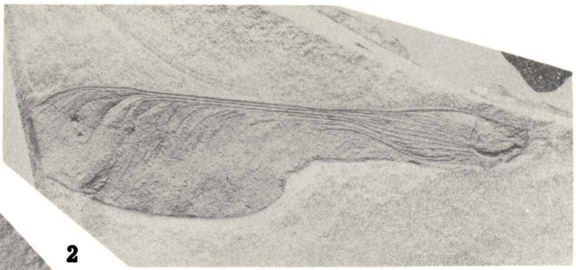

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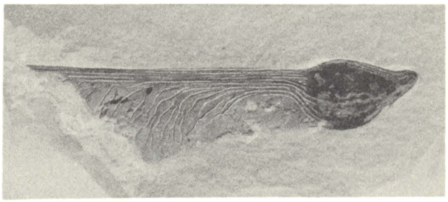

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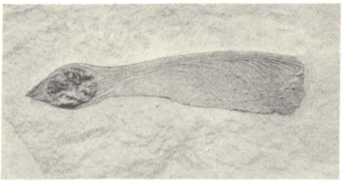

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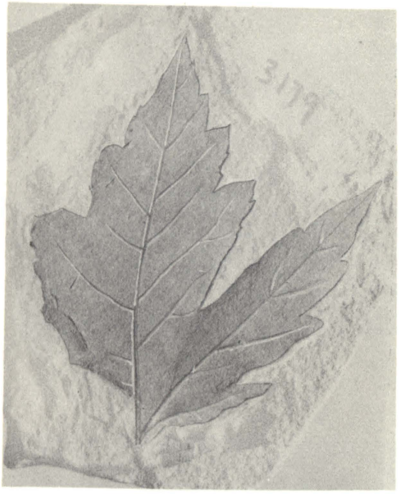

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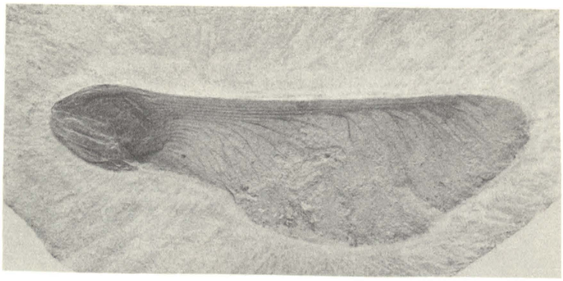

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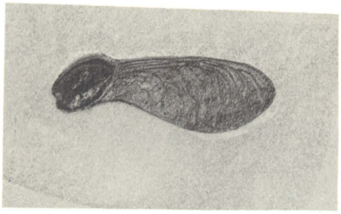

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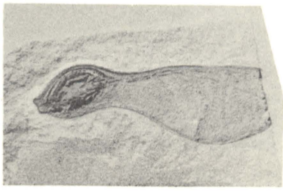

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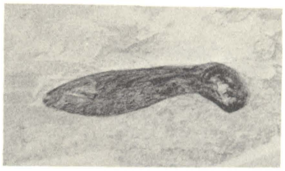

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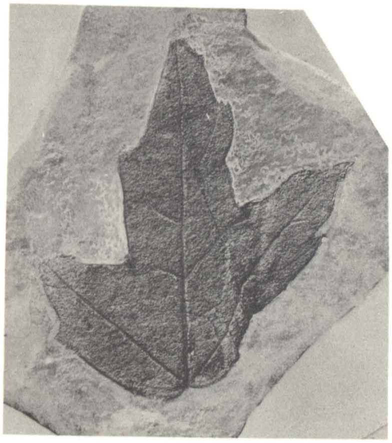

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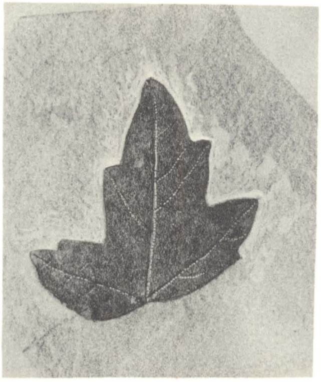

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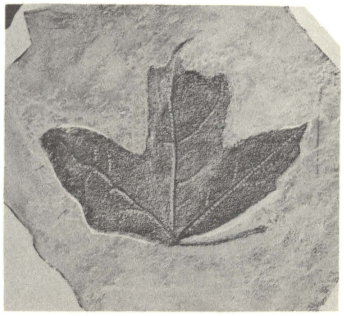

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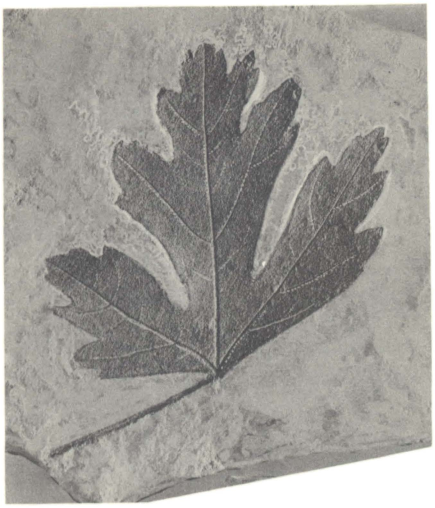

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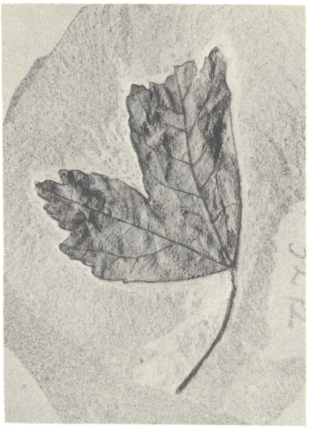

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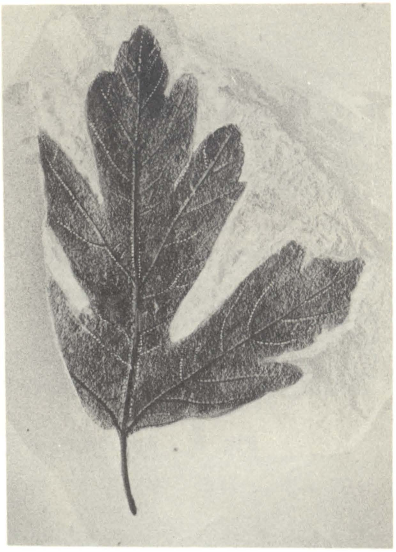

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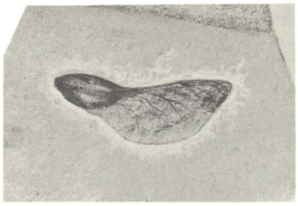

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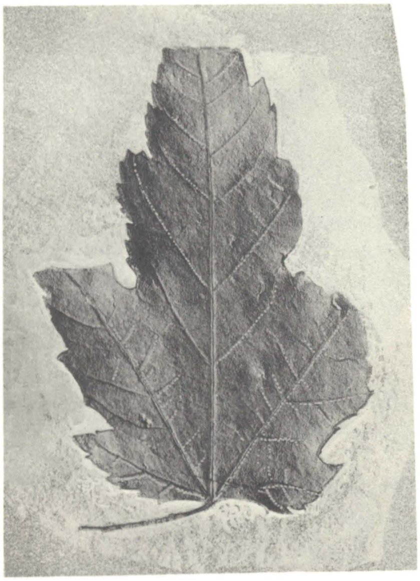

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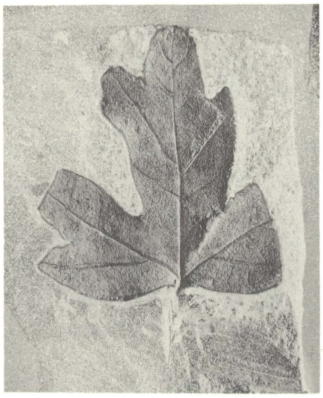

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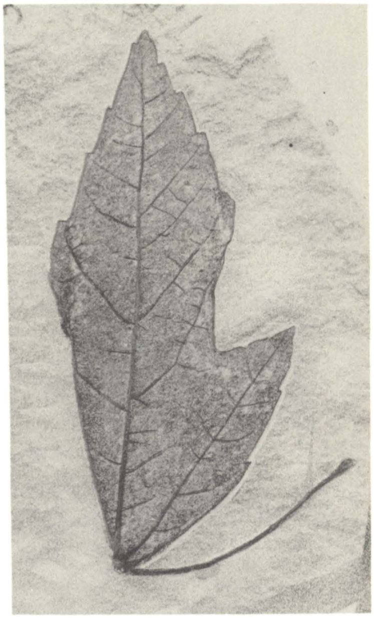

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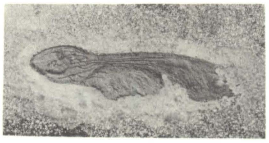

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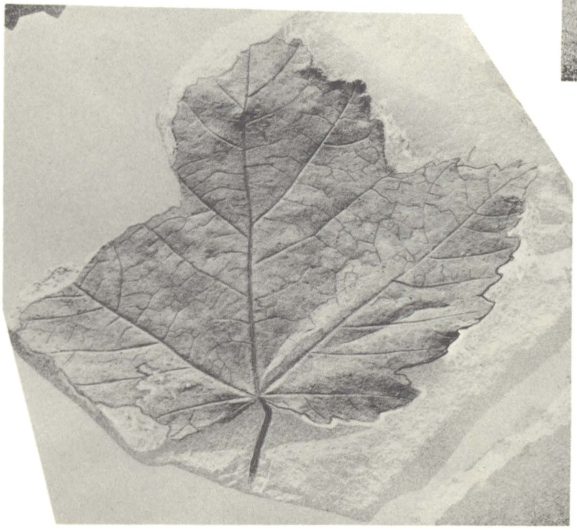

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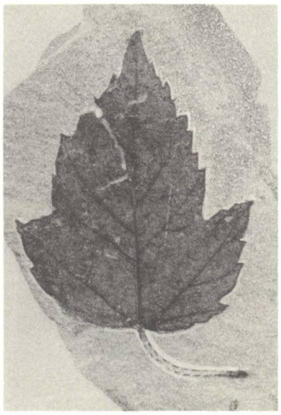

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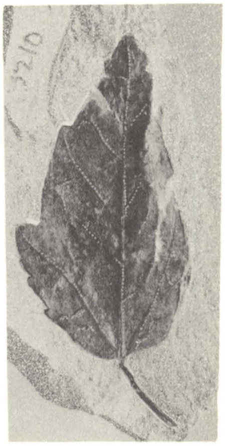

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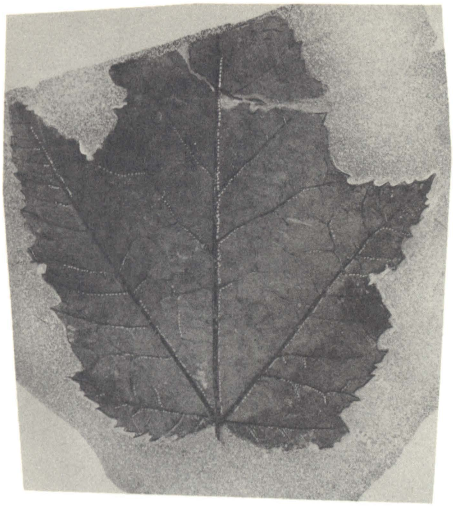

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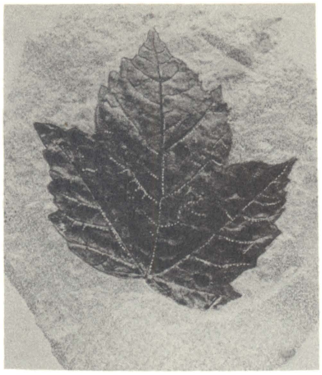

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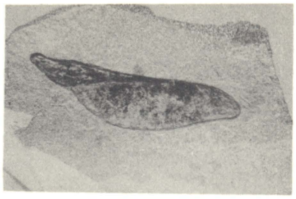

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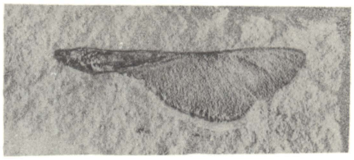

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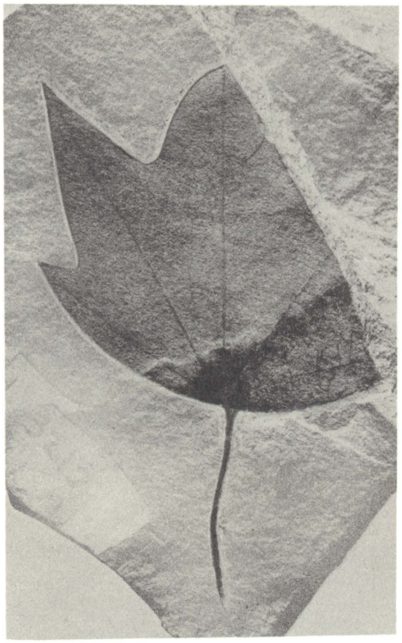

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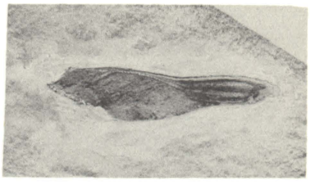

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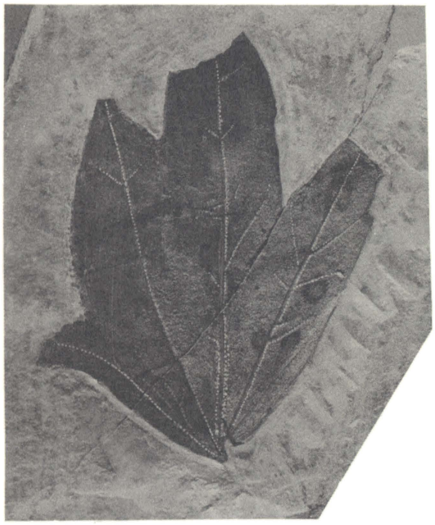

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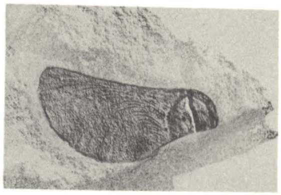

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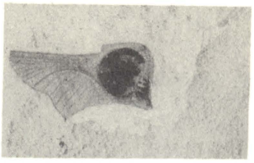

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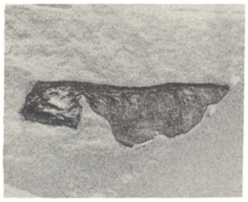

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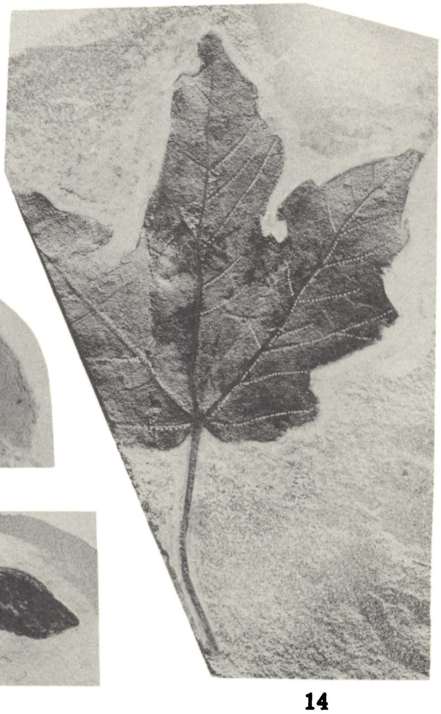

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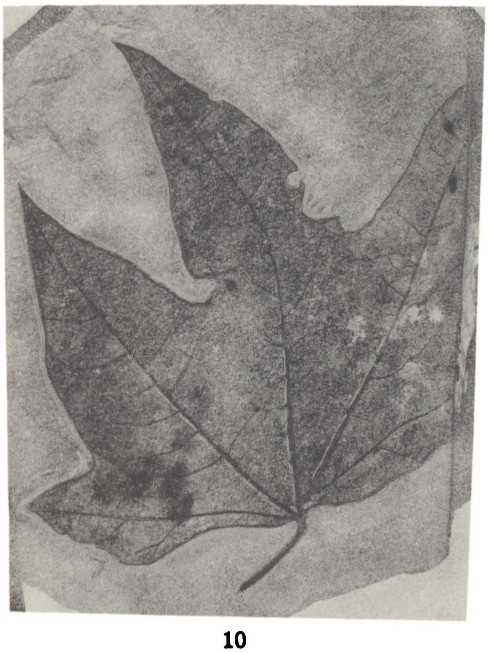

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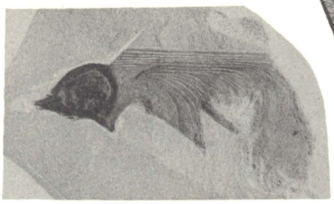

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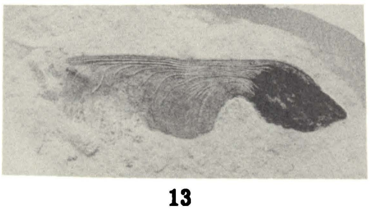

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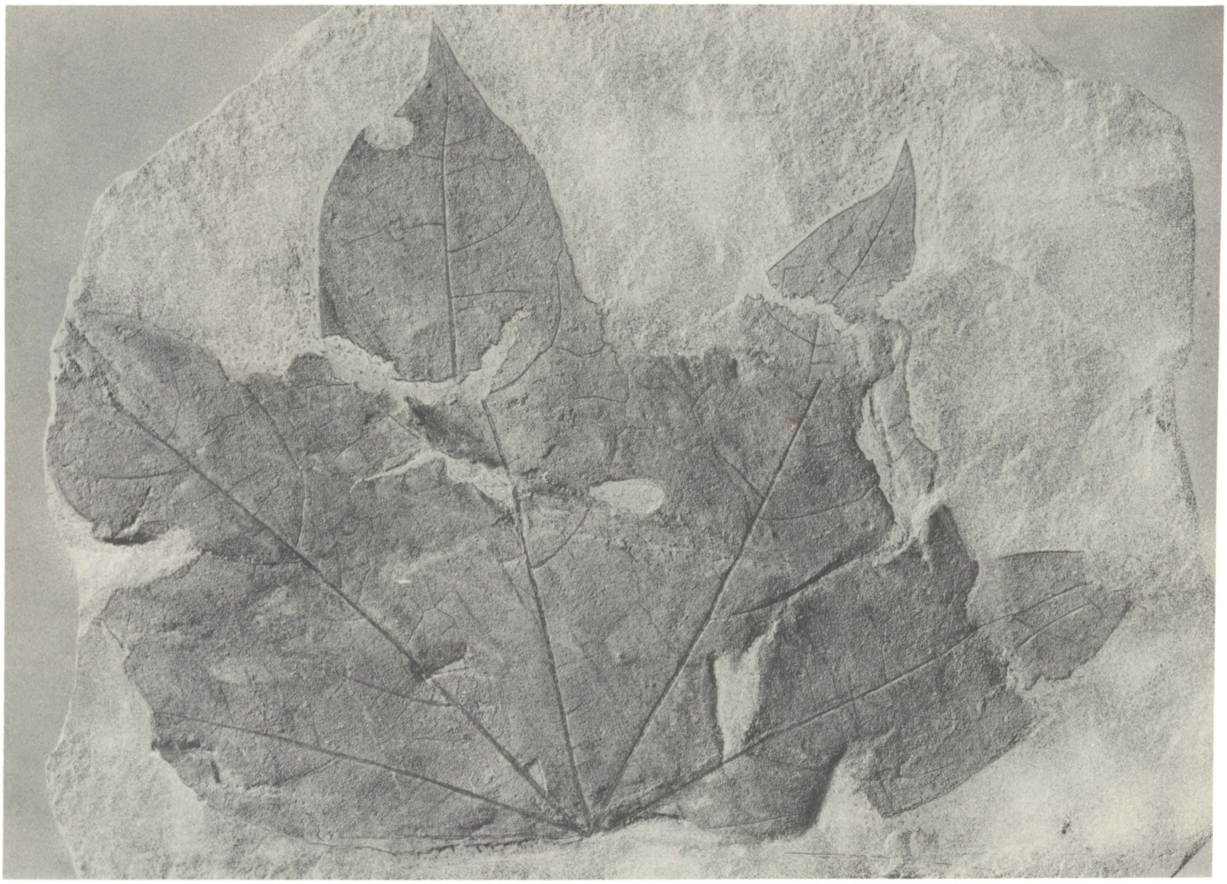

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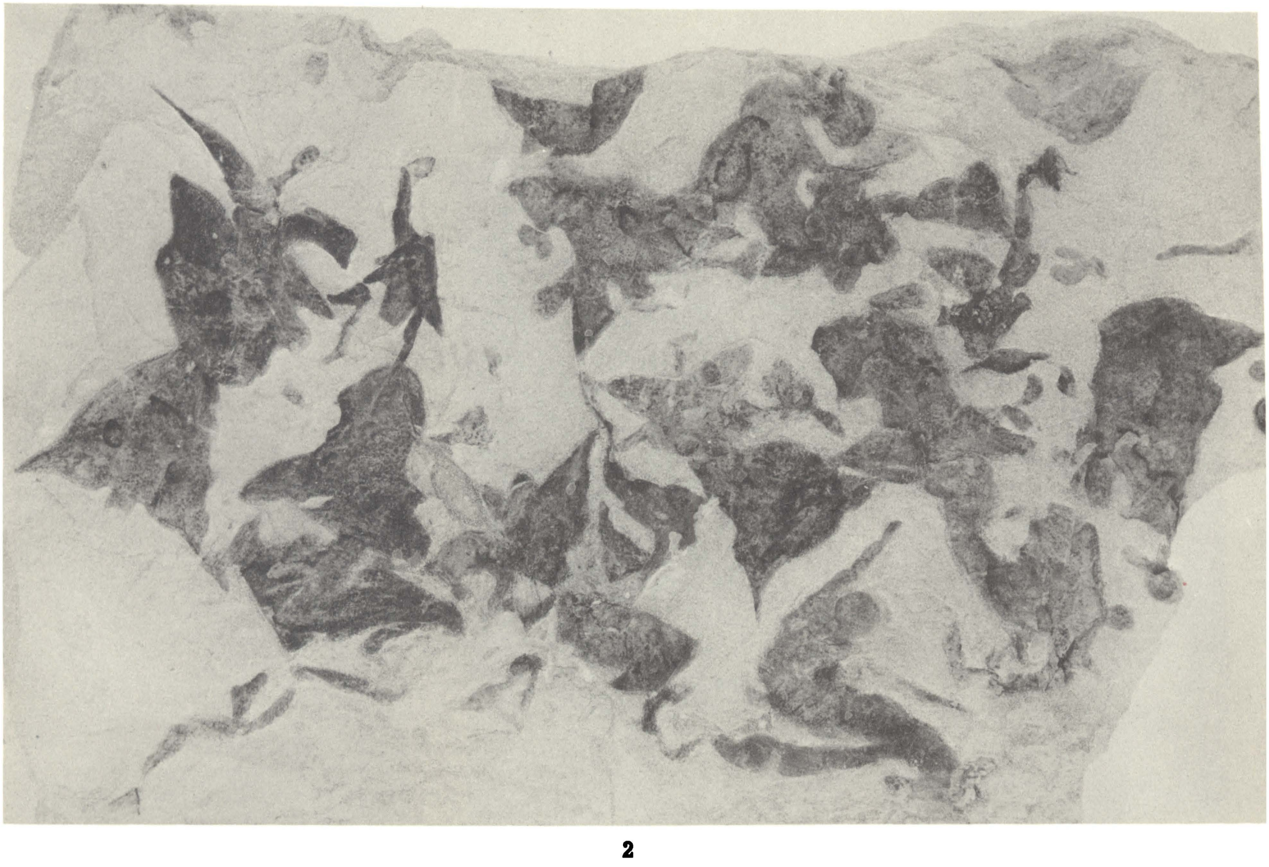

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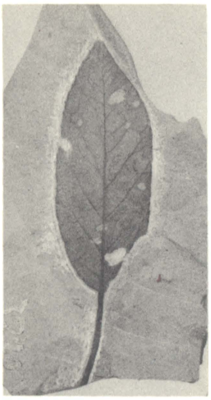
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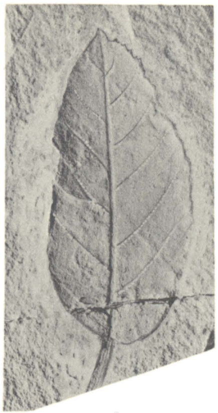
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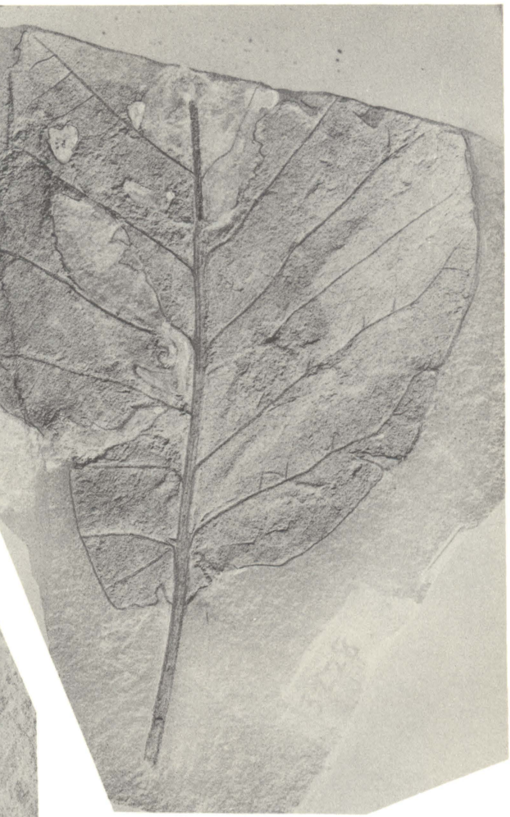
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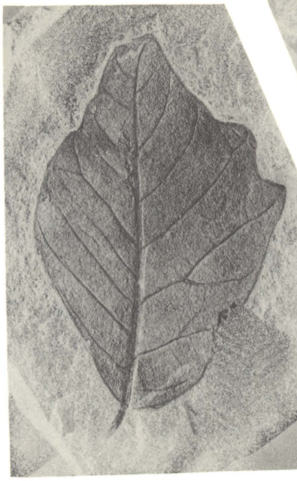
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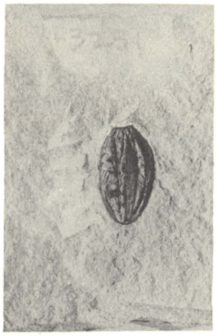
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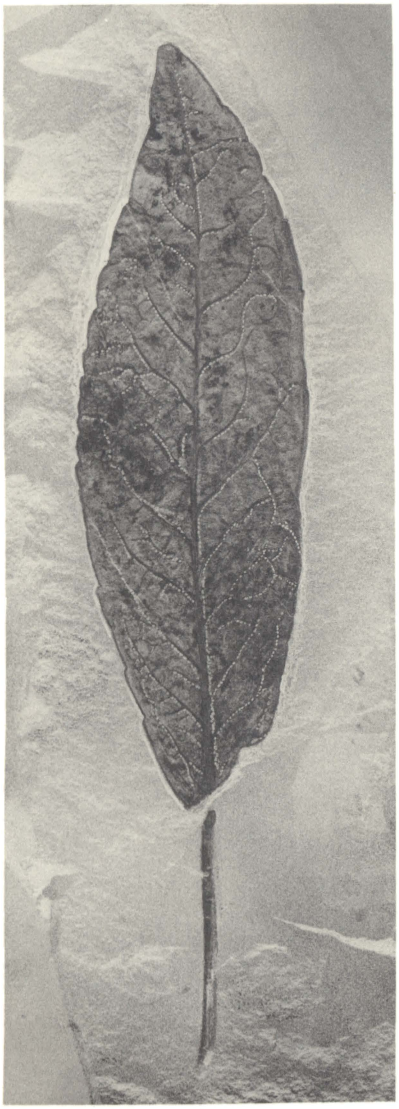
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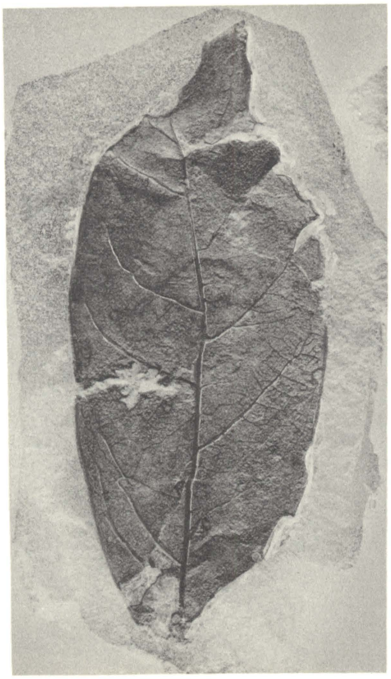
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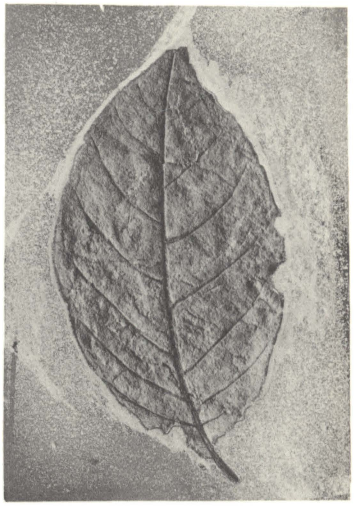
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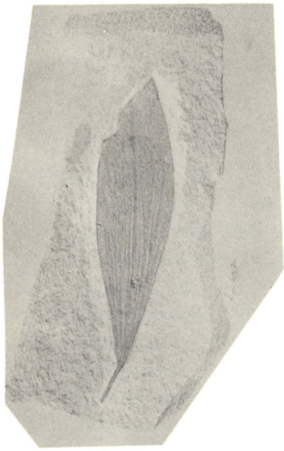

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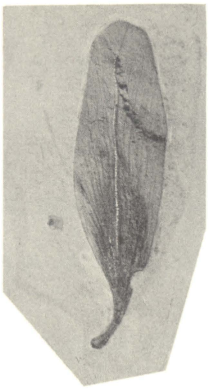

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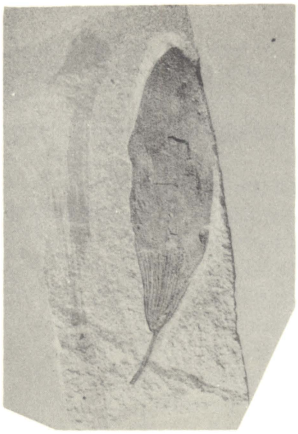

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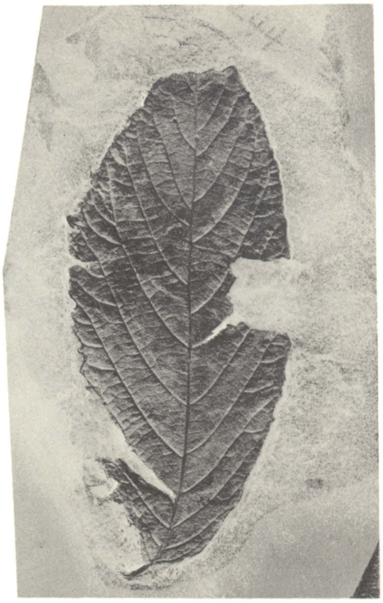

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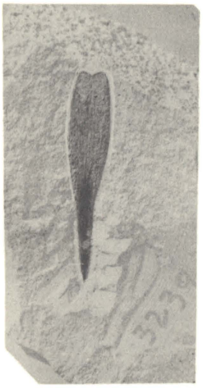

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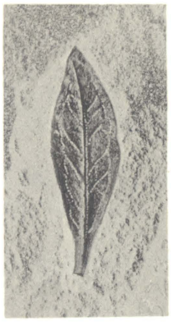

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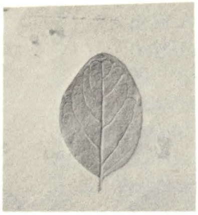

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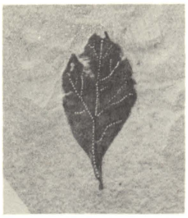

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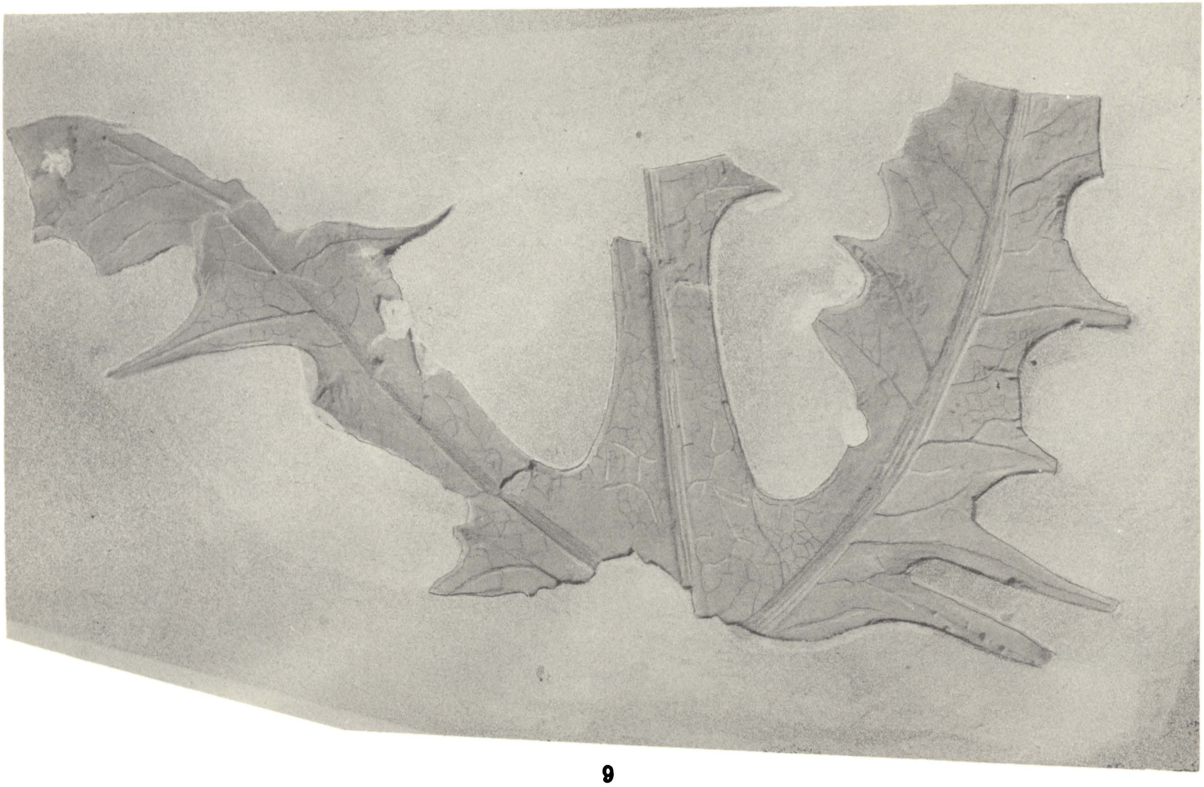

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